CE YEAR 2000 COMPLIANT

User's Guide

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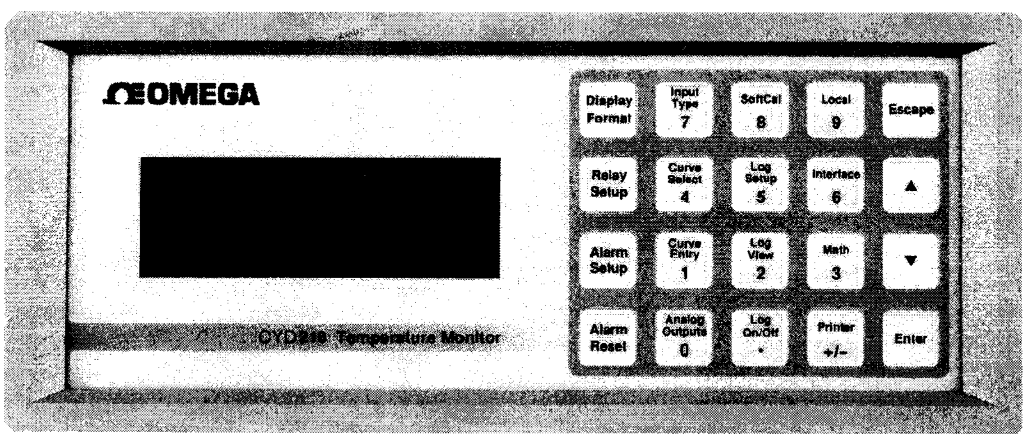

CYD218 SERIES
Cryogenic Digital Thermometers

MADE IN USA

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OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

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FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

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3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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CHAPTER 1

INTRODUCTION

1.0 GENERAL

The Model CYD218 is an eight input temperature monitor that can be used with diode or resistive temperature sensors. The measurement input was designed for the demands of cryogenic temperature measurement. The low noise, high resolution, and wide operating range of the temperature monitor make it ideal for non-cryogenic applications as well.

There are two versions of the Model CYD218, the Model CYD218S and Model CYD218E. Both versions have the same sensor measurement and display capabilities but include different interfaces.

Table 1-1. Supported Omega Sensors *

Type	Model	Temp. Range
Diodes		
Silicon Diode	CY7-SD	1.4 – 475 K
Positive Temperature Coefficient RTDs		
100 Ω Platinum	PT-100, 250 Ω Full Scale	30 – 675 K
100 Ω Platinum	PT-100, 500 Ω Full Scale	30 – 800 K

* Sensors sold separately.

The **Model CYD218S** has many interface features intended for system integration and automated data collection that make it useful for cryogenic and noncryogenic applications. The Model CYD218S includes two computer interfaces, IEEE-488 and serial. Data logging memory and printer capability are included to help automate data collection. Two analog voltage outputs, an alarm feature and eight relays enhance system integration.

The **Model CYD218E** is configured to have a lower selling price but maintains the same level of performance. It includes a serial computer interface, data logging memory and printer capability. The alarm feature is also present on the Model CYD218E, but there are no relays. *The CYD218E has all the features and specifications of the 218S except IEEE-488 interface, analog voltage outputs and relays.*

1.1 FEATURES

PTC Resistor Measurements

The Model CYD218 can read up to eight 100 Ω, 1000 Ω positive temperature coefficient (PTC) or any other PTC resistive sensors using their standard curves or individual calibrations. Platinum RTDs are known for their wide range of operation and uniform sensitivity. The CYD218 can read Platinum RTDs to achieve temperature readings greater than 1000 K (727 °C). Platinum RTDs sold by Omega are limited to 800 K (527 °C).

Diode Measurements

The CYD218 can read up to 8 Omega CYD or any other diode temperature sensor. Diode sensors are easily interchangeable and provide a wide measurement range from 1.4 – 475 K. The diodes follow a standard temperature response curve that eliminates the need for costly or time consuming individual calibration. The convenient SoftCal feature can be used to improve the accuracy of less expensive CY7-SD sensors.

Configurable Sensor Inputs

The Model CYD218 has eight constant current sources (one for each input) that can be configured for a variety of sensors. The inputs can be configured from the front panel or via computer interface and are grouped in two sets of four. Each set of four inputs are configured for the same sensor type (i.e. all 100 Ω Platinum or all Silicon Diodes, etc.).

Sensor Input Reading Capability

The Model CYD218 has two high resolution A/D converters to increase its update rate. It can read sensor inputs more quickly than other scanning monitors because it does not have to wait for current source switching. The result is 16 new readings per second allowing all inputs to be read twice each second. Inputs can be turned off to obtain a higher reading rate on fewer sensors. All readings can be read out of the instrument with the IEEE-488 interface. The serial interface can also be used to read all readings if it is operated efficiently. The display is updated twice each second.

Features (Continued)

Temperature Response Curves
The Model CYD218 has standard temperature sensor response curves for silicon diodes and platinum RTDs. It can support a wide variety of temperature sensors that do not have a standard curve because a unique 200-point user curve can be stored for each of the eight inputs. User curves can be entered from the front panel or with a computer interface. The built in SoftCal™ algorithm can also be used to generate improved curves for Silicon diodes and platinum RTDs that are stored as user curves.

Configurable Display
The eight display locations on the Model CYD218 are user configurable. These locations can be used to display a single readout for each of the eight inputs or for more than one readout for fewer inputs. Sources for readout data are temperature units, sensor units and results of the math function. Input number and data source are always displayed for convenience.

1.2 SPECIFICATIONS

Thermometry

Number of Inputs:	8
Input Configuration:	Two groups of four. Each group must contain same input type.
Measurement Type:	Four-lead differential.
Excitation:	Eight constant current sources.
Supported Sensors (temp. range):	Silicon Diode, RTDs: 100 Ω Platinum, 1000 Ω Platinum,
Accuracy/Resolution:	See Table 1-2.
Maximum Update Rate:	16 readings per second total.
Standard Curves:	Silicon Diode #10, DT-500D, PT-100, PT-1000.
User Curves:	Room for eight (one per input). 200 point maximum for each.
SoftCal:	Improves accuracy of CY7-SD diode to ±0.25 K from 30 K to 375 K. Improves accuracy of Platinum RTDs to ±0.25 K from 70 K to 325 K. Stored as user curves.
Math:	Maximum, Minimum, and Linear Equation.
Filter:	Averages 2 to 64 input readings.

Front Panel

Display:	4 line by 20 character backlit LCD display.
Number of input displays:	1 to 8.
Display Units:	K, C, V, Ω.
Display Update Rate:	All displayed inputs twice in one second.
Temperature Display Resolution:	0.001° between 0° - 99.999°, 0.01° between 100° - 999.99°, 0.1° above 1000°.
Sensor Units Display Resolution:	Sensor dependent, to 5 digits.
Display Annunciators:	Remote (R), Alarm (A), Data Logging (D), Max (>), Min (<), Linear (/).
Keypad:	20-Key membrane, numeric and specific functions.
Front Panel Curve Entry:	Yes.

Interface

IEEE-488.2 Interface (CYD218S):	SH1,AH1,T5,L4,SR1,RL1,PP0,DC1,DT0,C0,E1
Serial Interface:	RS-232C Electrical, DE-9 Connector, 9600 BAUD.
Printer Capability:	Support for serial printer through serial interface. Used with Data Log parameters.
Alarms:	
Number:	16 - High and low for each input.
Data Source:	Temperature, sensor units, linear equation.
Settings:	Units, High Setpoint, Low Setpoint, Deadband, Latching or Non-Latching, Audible on or off.
Actuators:	Display annunciator, beeper, relays (218S).
Relays (218S):	
Number:	8
Contacts:	Normally Open (NO), Normally Closed (NC), and Common (C).
Contact Rating:	30VDC at 5A.
Operation:	Each input may be configured to actuate any or all of the 8 relays. Relays may be activated on high, low, or both alarms for any input, or manually.
Corrected Analog Output (CYD218S):	
Scale:	User selected.
Range:	±10V
Resolution:	1.25mV
Accuracy:	±2.5mV
Minimum Load:	1 kΩ

Data Logging

Readings:	1 – 8 per record.
Operation:	Store Data Log records in memory or send them to the printer. Users may display, print, or retrieve stored data by computer interface.
Data memory:	Maximum of 1500 single reading records, non-volatile.

General

Ambient Temperature:	15 – 35 °C at rated accuracy. 10 – 40 °C at reduced accuracy.
Power Requirement:	100, 120, 220, 240VAC, +5% –10%, 50 or 60Hz, 18 VA.
Size:	217 mm W × 90 mm H × 317 mm D, half rack.
Weight:	3 kilograms (6.6 pounds).
Approval:	CE Mark (contact Omega Engineering for availability)

Sensor Type	Silicon Diode	100Ω Platinum RTD 500Ω Full Scale	1000Ω Platinum RTD
Temperature Coefficient	Negative	Positive	Positive
Sensor Units	Volts (V)	Ohms (Ω)	Ohms (Ω)
Input Range	0 – 2.5 V	0 – 500 Ω	0 – 5000 Ω
Sensor Excitation (Constant Current)	10 µA ±0.01%	1 mA ±0.3%	1 mA ±0.3%
Display Resolution (Sensor Units)	100 µV	10 mΩ	100 mΩ
Example Sensor	CY7-SD-CO-13 with 1.4H Cal.	PT-103 with 14J Cal.	PT-1001[2] with 1.4J Cal.
Temperature Range	1.4 – 475 K	30 – 800 K	30 – 800 K
Standard Sensor Curve	Curve 10	DIN 43760	Scaled from DIN 43670
Typical Sensor Sensitivity	–30 mV/K at 4.2 K –1.9 mV/K at 77 K –2.4 mV/K at 300 K –2.2 mV/K at 475 K	0.19 Ω/K at 30 K 0.42 Ω/K at 77 K 0.39 Ω/K at 300 K 0.35 Ω/K at 675 K 0.33 Ω/K at 800 K	1.9 Ω/K at 30 K 4.2 Ω/K at 77 K 3.9 Ω/K at 300 K 3.3 Ω/K at 800 K
Measurement Resolution: Sensor Units Temperature Equivalence	 20 uV 1 mK at 4.2 K 11 mK at 77 K 10 mK at 300 K 10 mK at 475 K	 2 mΩ 10.6 mK at 30 K 10 mK at 77 K 10 mK at 300 K 10 mK at 675 K 10 mK at 800 K	 20 mΩ 10.6 mK at 30 K 10 mK at 77 K 10 mK at 300 K 10 mK at 800 K
Electronic Accuracy: Sensor Units Temperature Equivalence	 ±160 uV ±0.01% RDG ±11 mK at 4.2 K ±138 mK at 77 K ±88 mK at 300 K ±77 mK at 475 K	 ±0.004 Ω ±0.02% RDG ±25 mK at 30 K ±18 mK at 77 K ±70 mK at 300 K ±162 mK at 675 K ±187 mK at 800 K	 ±0.06 Ω ±0.04% RDG ±40 mK at 30 K ±33 mK at 77 K ±135 mK at 300 K ±370 mK at 800 K
Temperature Accuracy including electronic accuracy, CalCurve and calibrated sensor	±31 mK at 4.2 K ±193 mK at 77 K ±138 mK at 300 K ±177 mK at 475 K	±45 mK at 30 K ±38 mK at 77 K ±105 mK at 300 K ±262 mK at 675 K ±287 mK at 800 K	±60 mK at 30 K ±53 mK at 77 K ±170 mK at 300 K ±470 mK at 800 K
Magnetic Field Use	Recommended for $T \geq 60$ K & $B \leq 3$ T	Recommended for $T > 40$ K & $B \leq 2.5$ T	Recommended for $T > 40$ K & $B \leq 2.5$ T

1.3 SAFETY

1.3.1 Handling Liquid Helium and Liquid Nitrogen

Liquid Helium (LHe) and liquid nitrogen (LN_2) may be used in conjunction with the Model CYD218. Although LHe and LN_2 are not explosive, there are certain safety considerations when handling them.

1.3.1.1 Handling Cryogenic Storage Dewars

Operate all cryogenic containers (dewars) in accordance with manufacturer instructions. Safety instructions are normally posted on the side of each dewar. Keep cryogenic dewars in a well-ventilated place, protected from the weather, and away from heat sources.

1.3.1.2 Liquid Helium and Nitrogen Safety Precautions

Transfer LHe and LN_2 and operate storage dewar controls in accordance with manufacturer/supplier instructions. During transfer, follow all safety precautions written on the storage dewar and recommended by the manufacturer.

WARNING: Liquid helium is a potential asphyxiant and can cause rapid suffocation without warning. Store and use in an adequately ventilated area. DO NOT vent the container in confined spaces. DO NOT enter confined spaces where gas may be present unless area is well-ventilated. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Liquid helium can cause severe frostbite to exposed body parts. DO NOT touch frosted pipes or valves. For frostbite, consult a physician immediately. If a physician is unavailable, warm the affected parts with water that is near body temperature.

Two essential safety aspects of handling LHe are adequate ventilation and eye and skin protection. Although helium and nitrogen gases are non-toxic, they are dangerous because they replace air in a normal breathing atmosphere. Liquid helium is an even greater threat because a small amount of liquid evaporates to create a large amount of gas. Store and operate cryogenic dewars in open, well-ventilated areas.

When transferring LHe and LN_2, protect eyes and skin from accidental contact with liquid or the cold gas issuing from it. Protect eyes with full face shield or chemical splash goggles; safety glasses (even with side shields) are inadequate. Always wear special cryogenic gloves (Tempshield Cryo-Gloves® or equivalent) when handling anything that is, or may have been, in contact with the liquid or cold gas, or with cold pipes or equipment. Wear long sleeve shirts and cuffless trousers long enough to prevent liquid from entering shoes.

1.3.1.3 Recommended First Aid

Post an appropriate Material Safety Data Sheet (MSDS) obtained from the manufacturer/distributor at every site that stores and uses LHe and LN_2. The MSDS specifies symptoms of overexposure and first aid.

If a person exhibits symptoms of asphyxia such as headache, drowsiness, dizziness, excitation, excessive salivation, vomiting, or unconsciousness, remove to fresh air. If breathing is difficult, give oxygen. If breathing stops, give artificial respiration. Call a physician immediately.

If exposure to cryogenic liquids or cold gases occurs, restore tissue to normal body temperature (98.6 °F) by bathing it in warm water not exceeding 105 °F (40 °C). DO NOT rub the frozen part, either before or after rewarming. Protect the injured tissue from further damage and infection and call a physician immediately. Flush exposed eyes thoroughly with warm water for at least 15 minutes. In case of massive exposure, remove clothing while showering with warm water. The patient should not drink alcohol or smoke. Keep warm and rest. Call a physician immediately.

1.3.2 Safety Summary

Observe these general safety precautions during all phases of instrument operation, service, and repair. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended instrument use. Omega Engineering assumes no liability for Customer failure to comply with these requirements.

The Model CYD218 protects the operator and surrounding area from electric shock or burn, mechanical hazards, excessive temperature, and spread of fire from the instrument. Environmental conditions outside of the conditions below may pose a hazard to the operator and surrounding area.

- Indoor use.
- Altitude to 2000 m.
- Temperature for safe operation: 5 °C to 40 °C.
- Maximum relative humidity: 80% for temperature up to 31 °C decreasing linearly to 50% at 40 °C.
- Power supply voltage fluctuations not to exceed ±10% of the nominal voltage.
- Overvoltage category II.
- Pollution degree 2.

Ground The Instrument
To minimize shock hazard, connect the instrument chassis and cabinet to an electrical ground. The instrument is equipped with a three-conductor AC power cable. Plug the power cable into an approved three-contact electrical outlet or use a three-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC) safety standards.

Ventilation
The instrument has ventilation holes in its top and bottom covers. Do not block these holes when the intrument is turned on.

Do Not Operate In An Explosive Atmosphere
Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits
Operating personnel must not remove instrument covers. Refer component replacement and internal adjustments to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Substitute Parts Or Modify Instrument
Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an authorized Omega Engineering Cryotronics, Inc. representative for service and repair to ensure that safety features are maintained.

Cleaning
Do not submerge instrument. Clean only with a damp cloth and mild detergent. Exterior only.

1.3.3 Safety Symbols

- Direct current (power line).
- Alternating current (power line).
- Alternating or direct current (power line).
- Three-phase alternating current (power line).
- Earth (ground) terminal.
- Protective conductor terminal.
- Frame or chassis terminal.
- On (supply).
- Off (supply).
- Equipment protected throughout by double insulation or reinforced insulation (equivalent to Class II of IEC 536 - see Annex H).
- Caution: High voltages; danger of electric shock. Background color: Yellow; Symbol and outline: Black.
- Caution or Warning - See instrument documentation. Background color: Yellow; Symbol and outline: Black.
- Fuse.

CHAPTER 2

SENSOR CONSIDERATIONS

2.0 GENERAL

Selecting the proper sensor is vital to good temperature monitoring. This chapter covers Temperature Sensor Selection in Paragraph 2.1), Calibrated Sensors in Paragraph 2.2, and Sensor Installation in Paragraph 2.3. This chapter describes cryogenic applications, but many ideas apply to other temperature measurements.

2.1 TEMPERATURE SENSOR SELECTION

This section covers general information about sensor selection. Find additional information on temperature sensor characteristics and selection in the Omega Temperature Catalog.

2.1.1 Temperature Range

The experimental temperature range must be known when choosing a sensor. Some sensors can be damaged by temperatures that are too high or too low. Manufactures recommendations should always be followed. Sensor sensitivity is also dependent on temperature and can limit a sensors useful range. It is important not to specify a range larger than necessary. If an experiment is being done at liquid helium temperature and a very high sensitivity is needed for good measurement resolution, that same resolution may not be required to monitor warm up to room temperature. Two different sensors may be required to tightly cover the range from helium to room temperature, but lowering the requirement on warm up may allow a less expensive, one sensor solution.

Another thing to consider when choosing a temperature sensor is that instruments like the Model CYD218 are not able to read some sensors over their entire temperature range. The Model CYD218 is limited to operation above 1 K in its standard configuration.

2.1.2 Sensor Sensitivity

Temperature sensor sensitivity measures how much a sensor signal changes when the temperature changes. It is important because so many measurement parameters relate to it. Resolution, accuracy, and noise floor depend on sensitivity. Many sensors have different sensitivities at different temperatures. For example, platinum sensor sensitivity is good at higher temperatures, but drops sharply below 30 Kelvin (K). It may be difficult to determine if a sensor has adequate sensitivity over the experimental temperature range. Table 1-2 lists sensor sensitivity translated into temperature resolution and accuracy at different points. This is typical sensor response and can be used as a guide to choose a sensor for the Model CYD218.

2.1.3 Environmental Conditions

Environmental factors such as high vacuum, magnetic field, corrosive chemicals, or even radiation may limit effectiveness of some sensors.

Magnetic field experiments are very common. Field dependence is an important selection criteria for temperature sensors used in these experiments. Table 1-2 states the field dependence of most common sensors.

2.1.4 Measurement Accuracy

Temperature measurements have several sources of error. Account for errors induced by both the sensor and the instrumentation when computing accuracy. The instrument has measurement error in both reading the sensor signal and calculating a temperature using a temperature response curve. Error results from the sensor comparison to a calibration standard; the sensor temperature response shifts with time and repeated thermal cycling. Instrument and sensor makers specify these errors, but some things help maintain good accuracy. For example, choose a sensor with good sensitivity in the most critical temperature range, as sensitivity minimizes the effect of most error sources. Install the sensor properly (Paragraph 2.3). Recalibrate the sensor and instrument periodically. Use a sensor calibration appropriate for the accuracy requirement.

2.1.5 Sensor Package

There are many types of sensor packages which generally determine sensor size, thermal and electrical contact to the outside, and sometimes limit temperature range. Some sensors may be purchased as bare chips without a package. When different packages are available for a sensor, consider the sensor mounting surface and how to heat sink the leads.

2.2 CALIBRATED SENSORS

It can be difficult to choose the right sensor, calibrate it, translate calibration data into a temperature response curve understandable to the Model CYD218, and load the curve into the instrument. Omega offers a variety of calibration and curve loading services to fit different accuracy requirements and budgets: Traditional Calibration in Paragraph 2.2.1, SoftCal in Paragraph 2.2.2, and Standard Curves in Paragraph 2.2.3.

2.2.1 Traditional Calibration

Calibration compares a sensor with an unknown temperature response to an accepted standard. Omega temperature standards are traceable to the U.S. National Institute of Standards and Testing (NIST) or the National Physical Laboratory in Great Britain. Calibrated sensors are more expensive than uncalibrated sensors.

Note instrument specifications before ordering calibrated sensors. A calibrated sensor is required when a sensor does not follow a standard curve *if* the user wishes to display in temperature. Otherwise the Model CYD218 operates in sensor units like ohms or volts. The Model CYD218 may not work over the full temperature range of some sensors. The Model CYD218 is limited to operation above 1 K or more.

2.2.2 SoftCal™

SoftCal is a good solution for applications that do not require the accuracy of a traditional calibration. The SoftCal algorithm uses the predictability of sensors that follow a standard curve to improve individual sensor accuracy. A few known temperature points are required to perform SoftCal.

The Model CYD218 can perform a SoftCal calibration. The user must provide one, two, or three known temperature reference points. Calibration range and accuracy depend on these points (see Paragraph 5.2).

2.2.3 Standard Curves

Some types of sensors behave very predictably and a standard temperature response curve can be created for them. Standard curves are a convenient and inexpensive way to get reasonable temperature accuracy. Sensors with a standard curve are often used when interchangability is important. Some individual sensors are selected for their ability to match a published standard curve and sold at a premium, but in general these sensors do not provide the accuracy of a calibrated sensor. For convenience, the Model CYD218 has several standard curves included in firmware.

2.3 SENSOR INSTALLATION

For more detailed information, Omega sensors ship with installation instructions that cover that specific sensor type and package. The Omega Engineering Temperature Measurement and Control Catalog includes an installation section as well. Omega Engineering also offers a line of Cryogenic Accessories. Many of the materials discussed are available through Omega Engineering and can be ordered with sensors or instruments.

2.3.1 Mounting Materials

The high vacuum used to insulate cryostats is one consideration in choosing sensor mounting materials. Choose materials with a low vapor pressure so they do not evaporate or out-gas and spoil the vacuum insulation. Metals and ceramics do not have this problem, but greases and varnishes must be checked. Another consideration is temperature extremes most sensors are exposed to. The linear expansion coefficient of a material becomes important when temperature changes are so large. Never try to permanently bond materials with linear expansion coefficients that differ by more than three. Use a flexible mounting scheme or the parts will break apart, potentially damaging them. The thermal expansion or contraction of rigid clamps or holders could crush fragile samples or sensors that do not have the same coefficient.

Omega
Silicon Diode Temperature Sensor

Standard

Standard sensors are interchangeable within the published tolerance band. Below are Standard Curve 10 Tolerance (Accuracy) Bands for CY7-SD.

Band	2 K* - 100 K	100 K - 305 K	305 K - 375 K
1	±0.25 K	±0.5 K	±1.0 K
2	±0.25 K	±1% of Temp.	
3	±0.5 K	±1.0 K	±2.0 K
4	±0.5 K	±1% of Temp.	
7	±1 K	±1% of Temp.	

* Temperatures down to 1.4 K only with Precision Calibrated Sensors.

To increase accuracy, Perform a SoftCal with the controller and sensor. After sensor calibration, the custom curve for that sensor replaces Standard Curve 10.

SoftCal™ Calibration

A 2-point SoftCal uses data points at 77.35 K and 305 K. A 3-point SoftCal uses data points at 4.2 K, 77.35 K, and 305 K.

Typical 2 Point Accuracy

±1.0 K	2 K to <30 K
±0.25 K	30 K to <60 K
±0.15 K	60 K to <345 K
±0.25 K	345 K to <375 K
±1.0 K	375 K to 475 K

Typical 3 Point Accuracy

±0.5 K	2 K to <30 K
±0.25 K	30 K to <60 K
±0.15 K	60 K to <345 K
±0.25 K	345 K to <375 K
±1.0 K	375 K to 475 K

Enter the voltage at 2 or 3 data points SoftCal capable instrument. A calibration report ships with the sensor.

Figure 2-1. Silicon Diode Sensor Calibrations and CalCurve

2.3.2 Sensor Location

Positioning a sensor is less problematic if the entire load and sample holder are at the same temperature. Unfortunately, this not the case in many systems. Temperature gradients (differences in temperature) exist because there is seldom perfect balance between the cooling source and heat sources. Even in a well-controlled system, unwanted heat sources like thermal radiation and heat conduction through mounting structures can cause gradients. For best accuracy, position sensors near the sample, so that little or no heat flows between the sample and sensor.

2.3.3 Thermal Conductivity

Thermal conductivity is the ability of heat to flow through a material. Copper and aluminum have good thermal conductivity, while stainless steel does not. Non-metallic, electrically-insulating materials like alumina oxide and similar ceramics have good thermal conductivity, while G-10 epoxy-impregnated fiberglass does not. Sensor packages, cooling loads, and sample holders should have good thermal conductivity to reduce temperature gradients. Surprisingly, connections between thermally conductive mounting surfaces often have very poor thermal conductivity. Thermal conductivity can change with temperature. Do not assume a heat sink grease that works well at room temperature and above will do the same job at low temperatures.

2.3.4 Contact Area

Thermal contact area greatly affect thermal conductivity because a larger area has more opportunity to transfer heat. Even when the size of a sensor package is fixed, thermal contact area can be improved with the use of a gasket material. A soft gasket material forms into the rough surface being mated to increase the area of the two surfaces that is in contact. Good gasket materials are soft, thin and have good thermal conductivity themselves. They must also withstand the environmental extremes. Indium foil and cryogenic grease are examples.

2.3.5 Contact Pressure

When sensors are permanently mounted, the solder or epoxy used to hold the sensor acts as both gasket and adhesive. Permanent mounting is not a good solution for everyone because it limits flexibility and can potentially damage sensors. Much care should be taken not to over heat or mechanically stress sensor packages. Less permanent mountings require some pressure to hold the sensor to its mounting surface. Pressure will greatly improve the action of gasket material to increase thermal conductivity and reduce thermal gradients. A spring clamp is recommended so that different rates of thermal expansion don't increase or decrease pressure with temperature change.

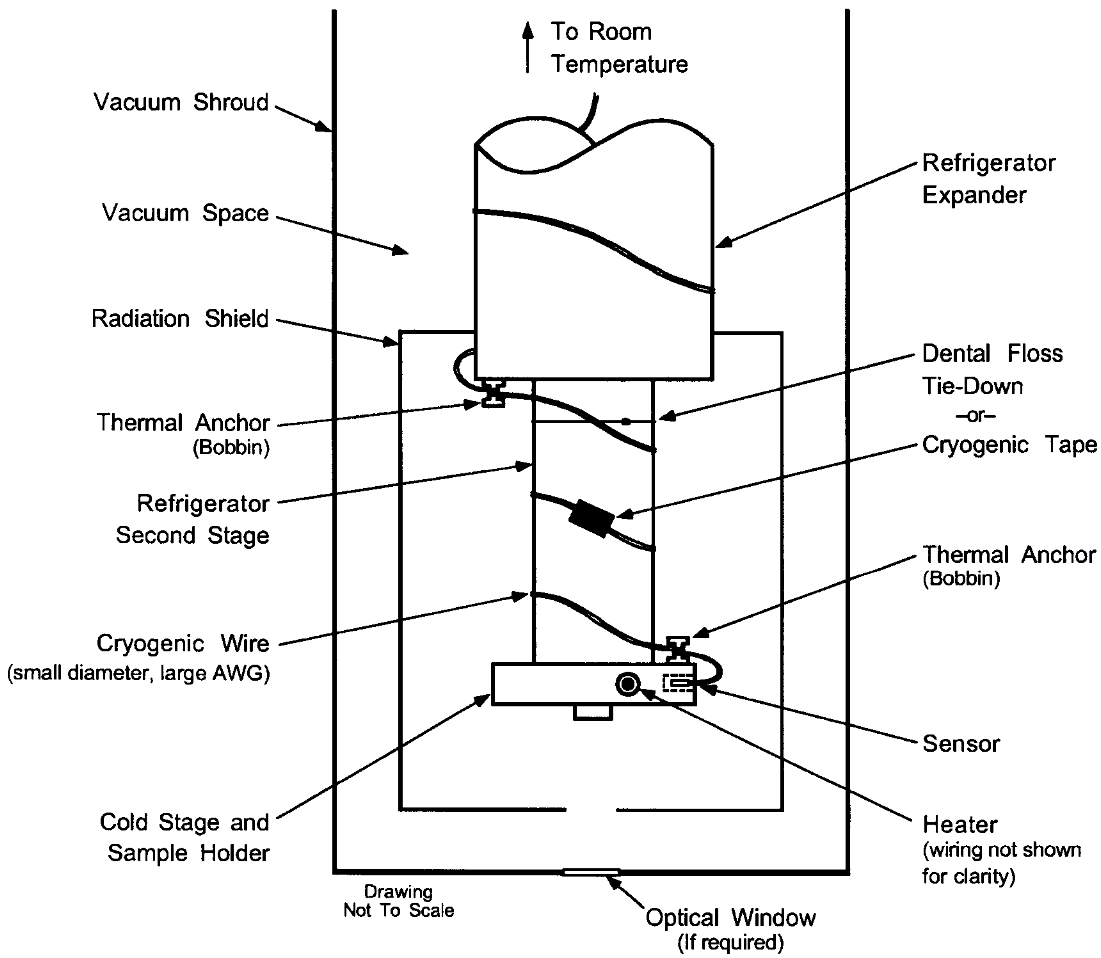

Figure 2-2. Typical Sensor Installation in a Mechanical Refrigerator

2.3.6 Lead Wire

Different types of sensors come with different types and lengths of electrical leads. In general a significant length of lead wire must be added to the sensor for proper heat sinking and connecting to a bulk head connector at the vacuum boundary. The lead wire must be a good electrical conductor, but a poor *thermal* conductor, or heat will transfer down the leads and change the temperature reading of the sensor. Small 30 to 40 AWG wire made of an alloy like phosphor bronze is much better than copper wire. Thin wire insulation is preferred and twisted wire should be used to reduce the effect of RF noise if it is present. The wire used on the room temperature side of the vacuum boundary is not critical so copper cable is normally used.

2.3.7 Lead Soldering

When additional wire is soldered to short sensor leads, care must be taken not to overheat the sensor. A heat sink such as a metal wire clamp or alligator clip will heat sink the leads and protect the sensor. Leads should be tinned before bonding to reduce the time that heat is applied to the sensor lead. Solder flux should be cleaned after soldering to prevent corrosion.

2.3.8 Heat Sinking Leads

Sensor leads can be a significant source of error if they are not properly heat sinked. Heat will transfer down even small leads and alter the sensor reading. The goal of heat sinking is to cool the leads to a temperature as close to the sensor as possible. This can be accomplished by putting a significant length of lead wire in thermal contact with every cooled surface between room temperature and the sensor. Lead wires can be adhered to cold surfaces with varnish over a thin electrical insulator like cigarette paper. They can also be wound onto a bobbin that is firmly attached to the cold surface. Some sensor packages include a heat sink bobbin and wrapped lead wires to simplify heat sinking.

2.3.9 Thermal Radiation

Thermal (black body) radiation is one of the ways heat is transferred. Warm surfaces radiate heat to cold surfaces even through a vacuum. The difference in temperature between the surfaces is one thing that determines how much heat is transferred. Thermal radiation causes thermal gradients and reduces measurement accuracy. Many cooling systems include a radiation shield. The purpose of the shield is to surround the load, sample, and sensor with a surface that is at or near their temperature to minimize radiation. The shield is exposed to the room temperature surface of the vacuum shroud on its outer surface, so some cooling power must be directed to the shield to keep it near the load temperature. If the cooling system does not include an integrated radiation shield (or one cannot be easily made), one alternative is to wrap several layers of super-insulation (aluminized mylar) loosely between the vacuum shroud and load. This reduces radiation transfer to the sample space.

2.3.10 Thermal EMF Compensation with Voltage Excitation

Sensors used at low temperatures must operate with little power dissipated in the sensor. To keep power low, the voltage across the sensor is kept low. Two major problems occur when measuring small DC voltages. The first is external noise entering the measurement through the sensor leads which is discussed with sensor setup. The second is the presence of thermal EMF voltages, sometimes called thermocouple voltages, in the lead wiring. Thermal EMF voltages appear whenever there is a temperature gradient across a piece of voltage lead. They can be canceled in the measurement with a similar temperature gradient in the other voltage lead. Thermal EMF voltages must exist because the sensor is almost never the same temperature as the instrument. Minimize them by careful wiring, verifying voltage leads are symmetrical in the type of metal used and how they are joined, and by keeping unnecessary heat sources away from the leads. Even in a well designed system, thermal EMF voltages can be an appreciable part of a low voltage sensor measurement.

The Model CYD218 has no thermal correction algorithm. Other instruments automatically reverse the current source polarity and average the positive and negative sensor readings to cancel the thermal EMF voltage. Account for thermal EMF errors when estimating Model CYD218 measurement accuracy.

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CHAPTER 3

INSTALLATION

3.0 GENERAL

This chapter covers general Model CYD218 installation instructions: Inspection and Unpacking in Paragraph 3.1, Repackaging for Shipment in Paragraph 3.2, and Rear Panel Definition in Paragraph 3.3.

3.1 INSPECTION AND UNPACKING

Inspect shipping containers for external damage. Make all claims for damage (apparent or concealed) or partial loss of shipment in writing to Omega Engineering within five (5) days from receipt of goods. If damage or loss is apparent, please notify the shipping agent immediately.

Open the shipping containers. Use the packing list included with the system to verify receipt of the instrument, sensor, accessories, and manual. Inspect for damage. Inventory all components supplied before discarding any shipping materials. If there is freight damage to the instrument, file proper claims promptly with the carrier and insurance company and notify Omega Engineering. Notify Omega Engineering immediately of any missing parts. Omega Engineering cannot be responsible for any missing parts unless notified within 60 days of shipment. See the standard Omega Engineering Warranty on the A Page (immediately behind the title page).

3.2 REPACKAGING FOR SHIPMENT

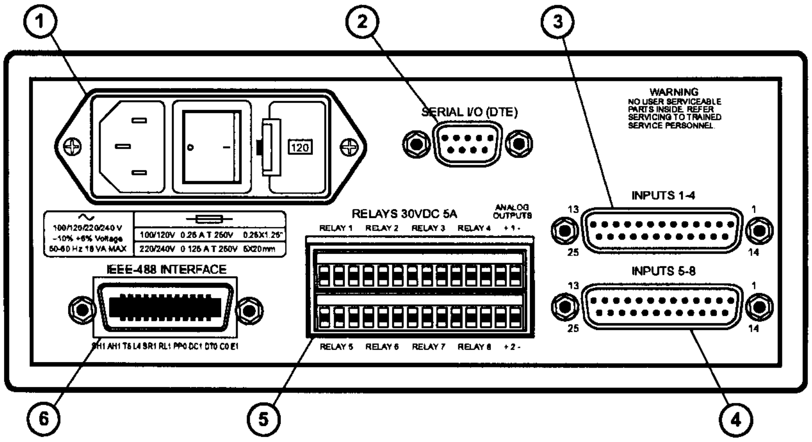
To return the Model CYD218, sensor, or accessories for repair or replacement, obtain a Return Goods Authorization (RA) number from Technical Service in the United States, or from the authorized sales/service representative from which the product was purchased. Instruments may not be accepted without a RA number. When returning an instrument for service, Omega Engineering must have the following information before attempting any repair.

1. Instrument model and serial number.
2. User name, company, address, and phone number.
3. Malfunction symptoms.
4. Description of system.
5. Returned Authorization (RA) number.

Wrap instrument in a protective bag and use original spacers to protect controls. Repack the system in the shipping carton (if available) and seal it with strong paper or nylon tape. Affix shipping labels and FRAGILE warnings. Write the RA number on the outside of the shipping container or on the packing slip.

3.3 REAR PANEL DEFINITION

CAUTION: Verify that the AC Line Voltage shown in the window on the fuse holder is appropriate for the intended AC power input. If the voltage setting is changed, remove and verify the proper fuse is installed before inserting the power cord and turning on the instrument. Always turn off the instrument before making any rear panel connections. This is especially critical when making sensor to instrument connections.



1. Line Input Assembly — See Paragraph 3.3.1
2. Serial I/O and Printer Connector — See Paragraph 6.2
3. Sensor Input Connector for Inputs 1-4 — See Paragraph 3.3.2.1
4. Sensor Input Connector for Inputs 5-8 — See Paragraph 3.3.2.1
5. Terminal Block for Relays and Analog Outputs (218S) — See Paragraph 3.3.3
6. IEEE-488 INTERFACE Connector (218S) — See Paragraph 6.1

Figure 3-1. Model CYD218 Rear Panel

3.3.1 Line Input Assembly

The line input assembly contains the line voltage selector, line fuse holder, and power cord connector. It is important to verify that the Model CYD218 is set to the appropriate line voltage and has the correct line fuse before it is powered on for the first time. See Table 3-1. If the final destination of the instrument is known when it ships, the factory configures the line input. Check this configuration; it is not unusual for an instrument to change hands before it reaches the end user. All line voltages discussed are single phase.

Table 3-1. AC Line Input Definitions

Indicator	Line Voltage Range	Fuse (slow blow)
100	90-106 VAC	0.25 A (250 V)
120	108-127 VAC	0.25 A (250 V)
220	198-233 VAC	0.125 A (250 V)
240	216-254 VAC	0.125 A (250 V)

3.3.1.1 Line Voltage and Fuse Verification

To verify proper line voltage selection, look at the indicator in the line input assembly window. If line voltage is not in the range shown in Table 3-1 for that indicator, change it as described in Paragraph 3.3.1.2. Remove fuse to verify its value (see Paragraph 3.3.1.3 for fuse replacement). Use slow blow fuses of the value specified in Table 3-1. Fuse values are also printed on the rear panel of the instrument for convenience.

WARNING: To avoid potentially lethal shocks, turn off controller and disconnect it from AC power line before performing these procedures.

CAUTION: For continued protection against fire hazard, replace only with the same type and rating of fuse as specified for the line for the line voltage selected.

3.3.1.2 Line Voltage Selection

Below is the procedure to change the instrument line voltage selector. Verify the fuse value whenever line voltage is changed.

1. Identify the line input assembly on the instrument rear panel.
2. Turn the line power switch OFF.
3. Remove the instrument power cord.
4. With a small screwdriver, release the drawer holding the line voltage selector and fuse.
5. Slide out the removable plastic fuse holder from the drawer.
6. Rotate the fuse holder until the proper voltage indicator shows through the window.
7. Verify the proper fuse value.
8. Re-assemble the line input assembly in the reverse order.
9. Verify the voltage indicator in the window of the line input assembly.
10. Connect the instrument power cord.
11. Turn the line power switch ON.

3.3.1.3 Fuse Replacement

Below is the procedure to remove and replace a line fuse. Use slow blow fuses with the value shown in Table 3-1. To change line input from the factory setting, use the appropriate fuse in the connector kit shipped with the instrument.

1. Locate line input assembly on the instrument rear panel.
2. Turn power switch OFF.
3. Remove instrument power cord.
4. With a small screwdriver, release the drawer holding the line voltage selector and fuse.
5. Remove fuse and replace it with appropriate slow blow fuse.
6. Re-assemble line input assembly in reverse order.
7. Verify voltage indicator in the line input assembly window.
8. Connect instrument power cord.
9. Turn power switch ON.

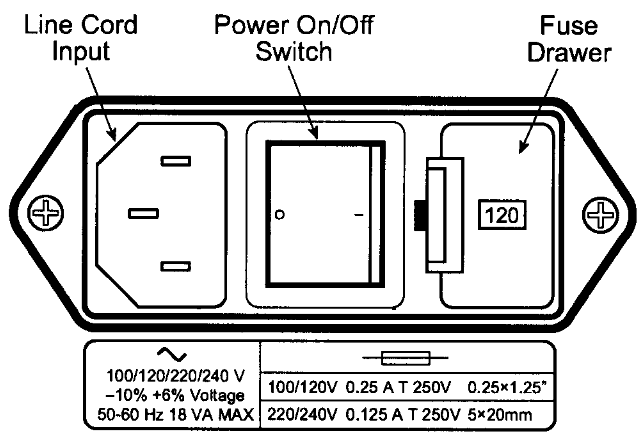


Figure 3-2 Power Fuse Access

3.3.1.4 Power Cord

The Model CYD218 includes a three-conductor power cord. Line voltage travels across the outer two conductors. The center conductor is a safety ground and connects to the instrument metal chassis when the power cord attaches to the power connector. For safety, plug the cord into an appropriate *grounded* receptacle.

3.3.1.5 Power Switch

The power switch turns the instrument ON and OFF and is located in the line input assembly on the instrument rear. When **I** is raised on the switch, the instrument is ON; when **O** is raised, the instrument is OFF. Do not remove instrument covers without first disconnecting the power cord, even if the power switch is off.

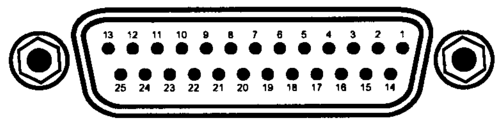
3.3.2 Sensor Inputs

This section covers Sensor Input Connector and Pinout in Paragraph 3.3.2.1, Sensor Lead Cable in Paragraph 3.3.2.2, Grounding and Shielding Sensor Leads in Paragraph 3.3.2.3, Sensor Polarity in Paragraph 3.3.2.4, Four-Lead Sensor Measurement in Paragraph 3.3.2.5, Two-Lead Sensor Measurement in Paragraph 3.3.2.6, and Lowering Measurement Noise in Paragraph 3.3.2.7.

3.3.2.1 Sensor Input Connector and Pinout

This paragraph details how to connect sensors to the Model CYD218 inputs. The sensor inputs operate with most resistive and diode sensors. See Paragraph 4.5 to configure inputs for a sensor type with software.

Disable unused sensor inputs with the Input Type key (Paragraph 4.5). It is possible for an overload condition on one sensor to affect the reading on another in the same connector. Wire redundant sensors in separate connectors for best reliability. Split fewer than eight sensors evenly between connectors for best reading efficiency.



Input Connector (Inputs 1-4)				Input Connector (Inputs 5-8)			
Pin	Desc.	Pin	Desc.	Pin	Desc.	Pin	Desc.
1	NC			1	NC		
2	S	14	S	2	S	14	S
3	1I+	15	1I–	3	5I+	15	5I–
4	1V+	16	1V–	4	5V+	16	5V–
5	S	17	S	5	S	17	S
6	2I+	18	2I–	6	6I+	18	6I–
7	2V+	19	2V–	7	6V+	19	6V–
8	S	20	S	8	S	20	S
9	3I+	21	3I–	9	7I+	21	7I–
10	3V+	22	3V–	10	7V+	22	7V–
11	S	23	S	11	S	23	S
12	4I+	24	4I–	12	8I+	24	8I–
13	4V+	25	4V–	13	8V+	25	8V–

Figure 3-3. Input Connector Pinouts (S = Shield, NC = No Connect)

3.3.2.2 Sensor Lead Cable

The sensor lead cable used outside the cooling system can be much different form what is used inside. Between the instrument and vacuum shroud, heat leak is not a problem, but error and noise pick up need to be minimized. Larger conductor, 22 to 28 AWG stranded copper wire is recommended because it has low resistance yet remains flexible when several wires are bundled in a cable. The arrangement of wires in a cable is also important. For best results, twist voltage leads, V+ and V– together and twist current leads I+ and I– together. Cover the twisted pairs of voltage and current leads with a braided or foil shield connected to the shield pin of the instrument. This type of cable is available through local electronics suppliers. Instrument specifications are given assuming 10 feet of sensor cable. Longer cables, 100 feet or more, can be used but environmental conditions may degrade accuracy and noise specifications.

3.3.2.3 Grounding and Shielding Sensor Leads

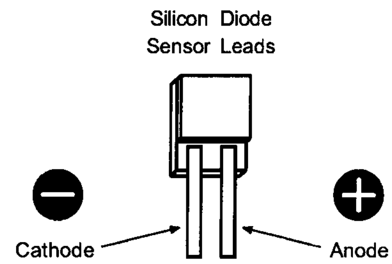
The sensor input measurements are NOT isolated from earth ground. Do not ground sensor leads outside of the instrument.

Shielding the sensor lead cable is important to keep external noise from entering the measurement. A shield is most effective when it is near the measurement potential so the Model CYD218 offers a shield that stays close to the measurement. Connect the sensor cable shield to the input connector shield pin. Do not terminate the shield at the opposite end. Do not connect the shield to earth ground on the instrument chassis or in the cooling system. Please note, the shell of the connector is in contact with the chassis so the cable shield should never touch the outer shell of the connector.

If a commercial cable is used in which the outer shield is tied to the connector shell do not terminate the shield at the sensor end or connect it to a shield pin in the connector.

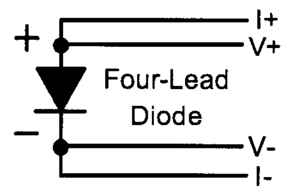
3.3.2.4 Sensor Polarity

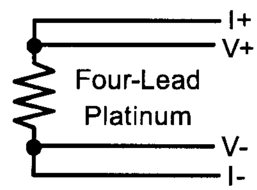
Omega Engineering sensors ship with instructions that indicate which sensor leads are which. It is important to follow these instructions for plus and minus leads (polarity) as well as voltage and current when applicable. Diode sensors do not operate in the wrong polarity. They look like an open circuit to the instrument. Two lead resistors can operate with any lead arrangement and the sensor instructions may not specify. Four-lead resistors may depend more on lead arrangement. Follow any specified lead assignment for four lead resistors. Mixing leads could give a reading that appears correct, but is not the most accurate.



3.3.2.5 Four-Lead Sensor Measurement

All sensors, including both two-lead and four-lead can be measured with a four-lead technique. Four-lead measurement eliminates the effect of lead resistance on the measurement. If it is not taken out, lead resistance is a direct error when measuring a sensor.



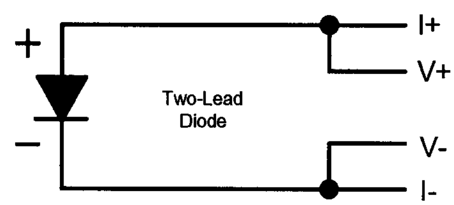


In a four lead measurement, current leads and voltage leads run separately to the sensor. With separate leads, there is little current in the voltage leads so their resistance does not enter into the measurement. Resistance in the current leads will not change the current as long as the voltage compliance of the current source is not reached. When two lead sensors are used in four lead measurements, the short leads on the sensor have an insignificant resistance.

NOTE: The Model CYD218 does not have three-lead measurement capability.

3.3.2.6 Two-Lead Sensor Measurement

Sometimes a crowded cryogenic system forces users to read sensors in a two-lead configuration because there are not enough feedthroughs or room for lead wires. If this is the case, plus voltage to plus current and minus voltage to minus current leads are attached at the back of the instrument or at the vacuum feedthrough.



The error in a resistive measurement is the resistance of the lead wire run with current and voltage together. If the leads contribute 2 or 3 Ω to a 10 kΩ reading, the error can probably be tolerated. When measuring voltage for diode sensors the error in voltage can be calculated as the lead resistance times the current, typically 10 uA. For example: a 10 Ω lead resistance times 10 uA results in a 0.1 mV error in voltage. Given the sensitivity of a silicon diode at 4.2 K the error in temperature would be only 3 mK. At 77 K the sensitivity of a silicon diode is lower so the error would be close to 50 mK. Again, this may not be a problem for every user.

NOTE: The Model CYD218 does not have three-lead measurement capability.

3.3.2.7 Lowering Measurement Noise

Good instrument hardware setup technique is one of the least expensive ways to reduce measurement noise. The suggestions fall into two categories: (1) Do not let noise from the outside enter into the measurement, and (2) Let the instrument isolation and other hardware features work to their best advantage.

- Use four-lead measurement whenever possible.
- Do not connect sensor leads to chassis or earth ground.
- Use twisted shielded cable outside the cooling system.
- Attach the shield pin on the sensor connector to the cable shield.
- Do not attach the cable shield at the other end of the cable, not even to ground.
- Run different inputs and outputs in their own shielded cable.
- Use twisted wire inside the cooling system.
- Use a grounded receptacle for the instrument power cord.
- Consider ground strapping the instrument chassis to other instruments or computers.

3.3.3 Terminal Block (MODEL CYD218S only)

The terminal block on the Model CYD218S rear panel contains signals for analog outputs and alarm relays. The terminal block connectors are detachable; remove the top or bottom half from the instrument for convenient wire installation. Use up to 12 AWG stranded copper wire with the terminals. Smaller wire is suitable for most applications.

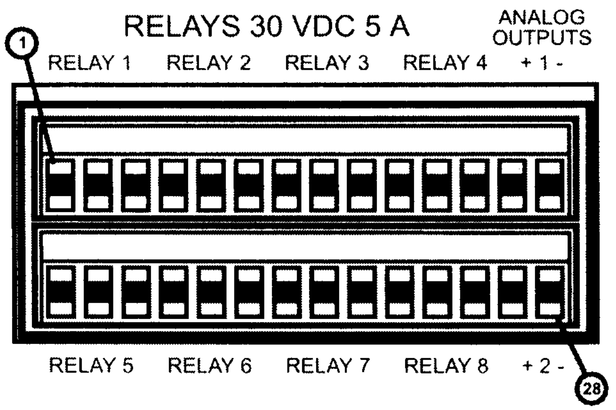


Figure 3-4. Terminal Block Connector

Table 3-2. Terminal Block Connector Pins

Pin	Description	Pin	Description
1	Relay 1 NC	15	Relay 5 NC
2	Relay 1 COM	16	Relay 5 COM
3	Relay 1 NO	17	Relay 5 NO
4	Relay 2 NC	18	Relay 6 NC
5	Relay 2 COM	19	Relay 6 COM
6	Relay 2 NO	20	Relay 6 NO
7	Relay 3 NC	21	Relay 7 NC
8	Relay 3 COM	22	Relay 7 COM
9	Relay 3 NO	23	Relay 7 NO
10	Relay 4 NC	24	Relay 8 NC
11	Relay 4 COM	25	Relay 8 COM
12	Relay 4 NO	26	Relay 8 NO
13	Analog 1 Signal	27	Analog 2 Signal
14	Analog 1 Gnd	28	Analog 2 Gnd

3.3.3.1 RELAYS (MODEL CYD218S only)

The Model CYD218 has eight relays most commonly associated with the alarm feature. If a relay is inactive (Off), it is in its normal state of open or closed. When the relay is active (On), it is in the opposite state. The relay contacts are isolated from the instrument ground. Connect to the relay contacts through the terminal block (see Paragraph 3.3.3).

3.3.3.2 Analog Outputs (MODEL CYD218S only)

Analog Output 1 and 2 on the Model CYD218S rear panel are voltage outputs that can be used for monitor applications (Figure 3-4). Their most basic function is a temperature monitor where they put out a voltage proportional to temperature.

Both analog outputs are variable DC voltage sources that can vary from -10 V to +10 V. The resolution of the analog output is 1.25 mV or 0.0125% of full scale. They can drive a resistive load of no less than 1 kΩ. The output is short protected so the instrument is not harmed if resistance is too small. It is not recommended because the additional load on instrument power supplies causes noise on internal circuits.

It is not recommended to attach the analog output ground to a ground outside the instrument. The output should be read by an instrument with an isolated or differential input wherever possible. Connecting to an external ground can cause noise in the analog output voltage or the sensor input measurement. If this cannot be avoided, try to keep the chassis of the two instruments at the same potential with a ground strap. Connect to the analog out contacts through the terminal block (see Paragraph 3.3.3).

3.3.4 Computer Interfaces

Refer to Chapter 6 for details about the IEEE-488 (Model CYD218S ONLY) and serial computer interfaces. See refer to Chapter 5 for details on connecting the serial port to a printer.

CHAPTER 4

OPERATION

4.0 GENERAL

This chapter covers Model CYD218 front panel operation. Display Screen Description in Paragraph 4.1, Keypad Description in Paragraph 4.2, Turning Power On in Paragraph 4.3, Display Setup in Paragraph 4.4, Input Type in Paragraph 4.5, Curve Select in Paragraph 4.6, Math in Paragraph 4.7, Analog Outputs in Paragraph 4.8, Alarm Setup and Operation in Paragraph 4.9, Alarm Reset in Paragraph 4.10, Relay Setup in Paragraph 4.11, Locking The Keypad in Paragraph 4.12, and Model CYD218 Reset in Paragraph 4.13.

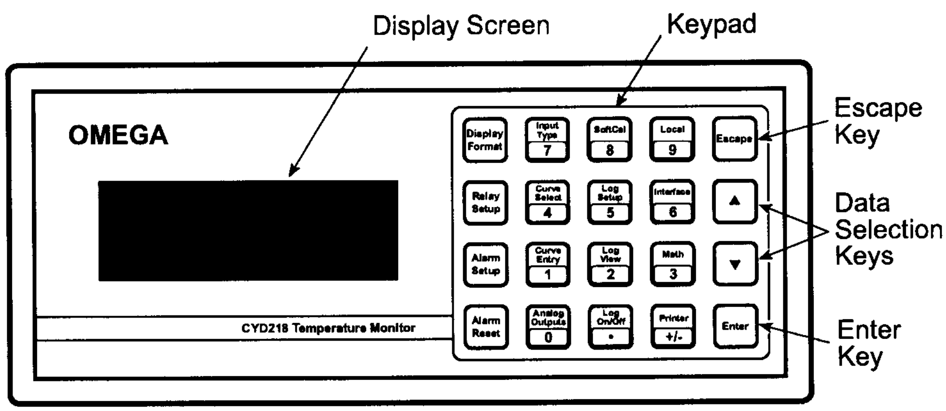


Figure 4-1. Model CYD218 Front Panel

4.1 DISPLAY SCREEN DESCRIPTION

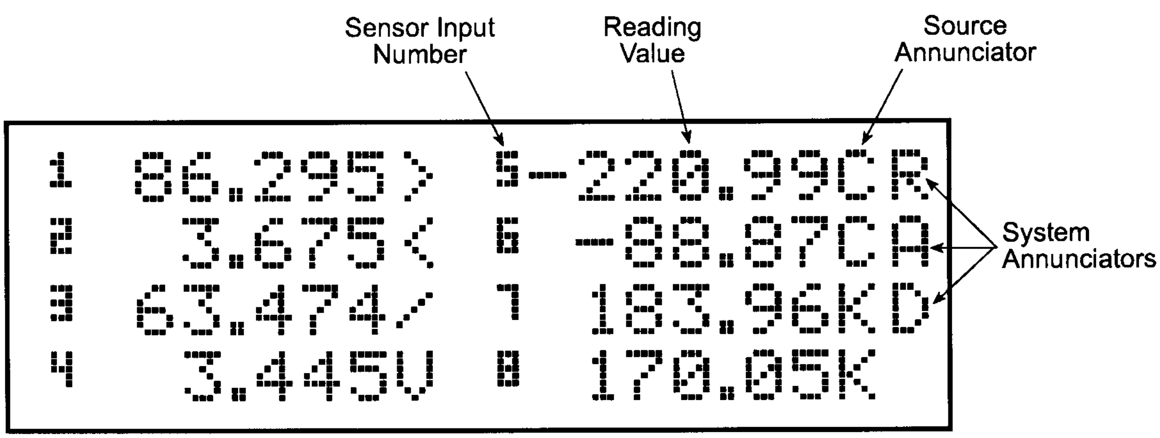


Figure 4-2. Model CYD218 Normal Display Screen Format

The Model CYD218 has a 4-line by 20-character backlit LCD. During normal operation it is divided into eight reading locations. Each of the eight reading locations can be configured by the user with the Display Format feature. Data from a sensor input can be displayed in any location. Sensor readings can be displayed in temperature or sensor units. Results of the math feature can be displayed at the same time as live readings. The reading location indicates the number of the sensor input to the left of the reading value. The character to the right of the reading value indicates units for live readings or shows an annunciator for one of the math values. The column of characters on the far right side of the display are used for system annunciators. See Figure 4-2. During keypad operation, display format changes to prompt for data entry.

Source Annunciators

K	Sensor input data in Kelvin
C	Sensor input data in Celsius
V or **Ω**	Sensor input data in sensor units
>	Result of maximum hold function
<	Result of minimum hold function
/	Result of linear equation output

System Annunciators

R	Remote IEEE-488 operation
A	Alarm Enabled
D	Data Log Enabled

Other Displays

(blank)	Display location off
DISABLED	Input for this location disabled.
ALM HIGH	High alarm triggered for input at this location.
ALM LOW	Low alarm triggered for input at this location.
NO CURVE	No curve selected for input at this location.
T. OVER	Temperature over curve capability.
T. UNDER	Temperature under curve capability.
S. OVER	Voltage or resistance over input capability.
S. UNDER	Voltage or resistance under input capability.

4.2 KEYPAD DESCRIPTION

The Model CYD218 has a 4-row by 5-column sealed membrane keypad. Keys are used for both beginning a setting change sequence and numeric data entry. The function of each key is described below followed by general operation.

Display Format	Formats the reading display including units selection. See Paragraph 4.4.
Relay Setup	Configures relays and associates them with the alarm feature (218S). See Paragraph 4.11.
Alarm Setup	Sets up alarms. See Paragraph 4.9.
Alarm Reset	Resets latched alarm state. See Paragraph 4.10.
Input Type	Configures an input set for sensor type. Also disables unused inputs. See Paragraph 4.5.
Curve Select	Selects a temperature response curve for an input. See Paragraph 4.6.
Curve Entry	Manually enters a temperature response curve and copies curve data. See Paragraph 5.1.
Analog Outputs	Configures analog voltage outputs (218S). See Paragraph 4.8.
SoftCal	Initiates SoftCal feature. See Paragraph 5.2.
Log Setup	Sets up data log feature. See Paragraph 5.3.1.
Log View	Views logged data. See Paragraph 5.3.3.
Log On/Off	Turns data logging on or off. See Paragraph 5.3.2.
Local	Returns instrument to local operation after remote IEEE-488 operation (218S). See Chapter 6.
Interface	Sets up the IEEE-488 (218S) or serial computer interface. See Chapter 6.
Math	Sets up math feature (Max, Min, Linear, and Filter). Also resets Max/Min. See Paragraph 4.7.
Printer	Sets up or initiates printer operation. See Paragraph 5.4.
Escape	Exits from a parameter setting sequence and returns to the normal display. During entry of numerical settings, press **Escape** once to clear the entry, twice to return to the normal display. Also resets memory.
Up Arrow	Increments parameter values or selections during setting sequence.
Down Arrow	Decrements parameter values or selections during setting sequence.
Enter	Accepts a new parameter value after setting sequence. Also used to lock the keypad.
Numbers 0-9	Enter numeric data during a setting sequence.

4.2.1 General Keypad Operation

There are three basic keypad operations: Direct Operation, Setting Selection, and Data Entry.

Direct Operation is where the key function occurs as soon as the key is pressed. Log On/Off, Local and Alarm Reset operate directly when the key is pressed.

Setting Selection allows the user to select from a list of values. During a selection sequence the Data Selection keys are used to select a parameter value. After a selection is made the Enter key is pressed to make the change and advance to the next setting, **Escape** is pressed to return to the Normal display. The instrument retains values changed prior to pressing **Escape**. Some selections are made immediately after pressing a function key like Interface. Most are part of a string of settings that often begins by entering an input number.

Data Entry expects the user to enter number data using the data entry keys. Data entry keys include the numbers 0-9, +/- and decimal point. Alarm setpoints are an example of parameters that require data entry. During a data entry sequence use the data entry keys to enter the number value, press the Enter key to accept the new data and advance to the next setting. Press **Escape** once to clear the entry, twice to return to the Normal display. The instrument retains values changed prior to pressing **Escape** twice. Most data entry operations are combined with other settings and grouped under a function key. Temperature or sensor unit parameters have the same setting resolution as the display resolution for their corresponding readings.

4.3 TURNING POWER ON

After verifying line voltage (Paragraph 3.3), plug the instrument end of the line cord (included with the connector kit) into the power and fuse assembly receptacle on the instrument rear. Plug the opposite end of the line cord into a properly grounded, three-prong receptacle. Flip power switch, located next to the line cord receptacle, to the **On (I)** position. The instrument initiates the following power up sequence: the instrument alarm sounds once; the display shows a startup message, then clears; the normal reading display appears. If the instrument does not complete the sequence or if a general error message displays, there may be a problem with the line power or the instrument. Individual messages in a reading location normally indicate that input setup is required.

4.4 DISPLAY SETUP

The Model CYD218 has a 4-line by 20-character backlit LCD. During normal operation it is divided into eight reading locations. Each of the eight reading locations can be configured by the user with the Display Format feature. Data from a sensor input can be displayed in any location. Sensor readings can be displayed in temperature or sensor units. Results of the math feature can be displayed at the same time as live readings. The reading location indicates the number of the sensor input to the left of the reading value. The character to the right of the reading value indicates units for live readings or shows an annunciator for one of the math values. The column of characters on the far right side of the display are used for system annunciators. See Figure 4-2. During keypad operation, display format changes to prompt for data entry. Reading locations numbered 1-8 correlate to the sensor input numbers in Figure 4-2.

To configure the display, press **Display Format**. The first display of the setting sequence, shown to the right, appears. Use the Data Selection keys to cycle through display locations (1-8). Press **Enter** when the desired location appears.

```
Display Format

Select with ▲▼
Display Location 1
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through input selections (1-8 or none) for the selected display location. Select None to blank the display location. Press **Enter** when the desired input appears. The same input may display in different locations simultaneously.

```
Display Format
Display Location 1
Select with ▲▼
Input 1
```

The third display in the setting sequence appears. Use the Data Selection keys to cycle through the source selections for the selected display location:

```
Display Format
Display Location 1
Select with ▲▼
Units K
```

K	Kelvin temperature reading from input.
C	Celsius temperature reading from input.
Sensor	Sensor units reading from input.
Linear	Linear equation data from input.
Min	Results of Minimum Math function.
Max	Results of Maximum Math function.

Press **Enter** when the desired source appears.The normal display appears with the selected sensor input and source displayed in the selected location.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**. Repeat the sequence for other display locations.

4.5 INPUT TYPE

The Model CYD218 supports a variety of temperature sensors sold by Omega Engineering and other manufactures. An appropriate sensor type must be selected for each group of inputs. Refer to Table 4-1 for a list of display messages and common sensor types. If a particular sensor is not listed in the Input Type selection look at Table 1-2 to find a sensor with similar range and excitation. Sensor type is selected for all sensors in a group 1-4 or 5-8. All sensors in a group must share the same excitation and range. The two groups can be set to a different type. It is recommended that all unused inputs are turned off.

To select sensor type, press **Input Type**. The display to the right appears. Use the Data Selection keys to cycle through the different sensor types for Input group 1-4. When the desired type appears, press **Enter**.

```
Math Setup
Input 1
Select with ▲▼
Linear Units K
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through the different sensor types for Input group 5-8. When the desired type appears, press **Enter**.

```
Math Setup
Input 1
Linear Variable M
 +1.0000
```

The third display in the setting sequence appears. Use the Data Selection keys to turn the displayed input On or Off, then press **Enter** to advance to the next input. Turn all unused inputs off for maximum reading rate.

```
Math Setup
Input 1
Linear Variable B
 +0.0000
```

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

After setting all Input Type parameters, the normal display appears. The message "Disabled" appears in the display location of any inputs that are turned off.

Table 4-1. Sensor Input Type Display Messages

Display Message	Sensor Type
2.5V Diode	Silicon Diode
7.5V Diode	GaAlAs Diode
250 Ohm Plat.	100 Ohm Platinum RTD <675K; Rhodium-Iron RTD
500 Ohm Plat.	100 Ohm Platinum RTD >675K
5k Ohm Plat.	1000 Ohm Platinum RTD
Cernox	Any NTC RTD 0-7500Ohm; Germanium; Carbon Glass; Cernox; Rox; Thermox

4.5.1 Optimizing the Update Rate

The maximum update rate of the Model CYD218 is 16 readings per second allowing all eight inputs to be read twice each second. Turning off unused inputs (Paragraph 4.1.5) permits a higher reading rate on fewer sensors (see Table 4-2). For maximum efficiency, split sensors evenly between the two input groups when using fewer than eight sensors. All new readings can be read from the instrument with either the IEEE-488 or serial interface. The display update rate remains at twice per second.

Table 4-2. Sensor Configuration Update Rates

Group 1-4 Inputs On	Group 5-8 Inputs On	Readings/Second (Individual Input)
1	—	16
1	5	8
1, 2	5, 6	4
1-4	5-8	2

4.6 CURVE SELECT

Each sensor input of the Model CYD218 must be assigned a temperature response curve if it is used to read temperature. If no temperature response curve is assigned to an input it will read in sensor units only. During curve selection only curves appropriate for the sensor type will be displayed so sensor type must be selected before curves.

Standard curves are included in the instrument and can be assigned to sensor inputs that match them. Standard curves included in the Model CYD218 are listed in Table 4-3.

Table 4-3. Standard Curves Included in the Model CYD218

Curve Number	Display Name	Sensor Type	Omega Sensor #	Curve Name	Temperature Range
1	CY7-SD	Silicon Diode	CYC	Curve 10	1.4 - 475 K
2	DT-500	Silicon Diode	CYC	Curve D	1.4 - 365 K
3	CTI	Silicon Diode	N/A	CTI Curve C	10 - 320 K
6	PT-100	100 Ω Platinum RTD	PT-100	DIN 43760	30 - 800 K
7	PT-1000	1000 Ω Platinum RTD	PT-1000	DIN 43760	30 - 800 K

Users may store a unique 200-point user curve for each of the eight inputs if standard curves are inadequate. User curves can be entered from the front panel or with a computer interface. The built-in SoftCal algorithm can also generate improved curves for Silicon diodes and platinum sensors stored as user curves. See Chapter 5 for details about user curves. User curves must be stored in the same location number as the sensor input. Once an appropriate user curve stores for a sensor input, it can be selected just like standard curves, but it can be used for only one input.

```
Curve Select

Select with ▲▼
Input 1
```

To select a temperature response curve, press **Curve Select**. The display to the right appears. Use the Data Selection keys to cycle through the inputs (1-8) for which to select a temperature response curve. Press **Enter** when the desired input appears.

```
Curve Select
Input 1
Select with ▲▼
DT-470
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through the temperature response curves. When the desired curve appears, press **Enter** to assign that curve to the selected input and return to the normal display.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

4.7 MATH

Simple math features are included for convenience and aid in setting up experiments. Readings can be filtered to quiet effects of a noisy environment. Max and Min readings can be captured. A linear equation can be applied to input data to correct system errors or improve performance of the analog outputs. Math features can be performed on all eight sensor inputs. Each input must be configured seperately.

4.7.1 Max/Min

The Max/Min feature simply captures and stores the highest (Max) and lowest (Min) reading taken since the last reset. The feature will only capture from one reading source so it is important to select a source. Max and min can be manually reset as described below. They are also reset when the instrument is turned off or parameters related to the input are changed.

```
Math Setup
Press Math Button
to Reset Max/Min,
Enter for Math Setup
```

To select a source for Max/Min, press **Math**. The display to the right appears. Press **Enter** to select an input for Max/Min.

```
Math Setup

Select with ▲▼
Input 1
```

The second display in the Math setting sequence appears. Use the Data Selection keys to select the sensor input (**1**-**8**) from which to capture and store the highest (Max) and lowest (Min) reading. Press **Enter** when the desired input appears.

```
Math Setup
Input 1
Select with ▲▼
Max/Min Units K
```

The third display in the Math setting sequence appears. Use the Data Selection keys to select the appropriate source for the selected sensor input:

K	Kelvin temperature reading from input.
C	Celsius temperature reading from input.
Sensor	Sensor units reading from input.
Linear	Linear equation data from input.

Press **Enter** when the desired source appears.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

4.7.1.1 Resetting Max/Min

To manually reset Max/Min, press **Math**. The display to the right appears. Press **Math** again to reset Max/Min. Max/Min automatically resets when the instrument is turned off or parameters related to the input change.

```
Math Setup
Press Math Button
to Reset Max/Min,
Enter for Math Setup
```

4.7.2 Linear

The Model CYD218 will process a simple linear equation **MX + B** for each sensor input. **M** = slope of a line, **X** = reading data from a sensor input, and **B** = offset of a line. The result can be displayed or directed to one of the analog voltage outputs.

```
Math Setup
Input 1
Select with ▲▼
Linear Units K
```

To set up the linear equation, press **Math**, select an input, then press **Enter** until the fourth display in the Math setting sequence appears. Use the Data Selection keys to select an appropriate source for the selected sensor input (**X**):

K Kelvin temperature reading from input.
C Celsius temperature reading from input.
Sensor Sensor units reading from input.

Press **Enter** when the desired source appears.

```
Math Setup
Input 1
Linear Variable M
 +1.0000
```

In the fifth display of the Math setting sequence, specify the **M** variable, then press **Enter**. Resolution is 5 digits (0.0001 to 9999.9).

In the sixth display of the Math setting sequence, specify the **B** variable, then press **Enter**. Resolution is 5 digits (0.0001 to 9999.9).

```
Math Setup
Input 1
Linear Variable B
 +0.0000
```

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

4.7.3 Filter

The reading filter applies exponential smoothing to the sensor input readings. If the filter is turned on for a sensor input all reading values for that input are filtered. The filter does not change the update rate on an input. Filtered readings are available as often as non filtered readings.

The number of filter points determines how much smoothing is done. One filter point corresponds to one new reading on that input. A larger number of points does more smoothing but also slows the instruments response to real changes in temperature. If the measured temperature changes quickly the reading will settle at the new value in about 6 times the number of filter points.

```
Math Setup
Input 1
Select with ▲▼
Filter Off
```

The filter window is a limit for restarting the filter. If a single reading is different from the filter value by more than the limit the instrument will assume the change was intentional and restart the filter. Filter window is set in percent of full scale range.

To set up the filter, press **Math**, select an input, then press **Enter** until the seventh display of the Math setting sequence appears. Use the Data Selection keys to turn the filter On or Off, then press **Enter** to continue.

```
Math Setup
Input 1
Select with ▲▼
Filter Points 07
```

On Filters all reading values for the specified input
Off No filtering for the specified input.

The eighth display of the Math setting sequence appears. Use the Data Selection keys to select the number of filter points, from 2 to 64. Press **Enter**.

The ninth display of the Math setting sequence appears.

```
Math Setup
Input 1
Select with ▲▼
Filter Window 08%
```

Use the Data Selection keys to select the filter window, from 1% to 10%, then press **Enter** to return to the normal display.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

4.8 ANALOG OUTPUTS (MODEL CYD218S ONLY)

The Model CYD218S has two analog voltage outputs numbered 1 and 2. They are commonly configured to send a voltage proportional to temperature to a strip chart recorder or data acquisition system. The outputs can also be manually controlled as a voltage source for any other application.

The analog outputs are variable DC voltage sources that can vary from +10V to -10V. The voltage is generated by a 14-bit D/A converter with resolution of 1.25 mV or 0.0125% of full scale. The output is short protected but should never be used to drive a resistance lower than 1 kΩ. Analog output terminals are in the detachable terminal block on the Model CYD218S rear panel.

The analog outputs each have three modes of operation: off, input, and manual. Once a mode is selected, the parameters associated with that mode follow on setting screens. The two outputs are configured independently and can have different modes.

To set the operating mode of an analog output, press **Analog Outputs**. The display to the right appears. Use the Data Selection keys to choose which output to configure (**1-2**), the press **Enter**.

```
Analog Outputs

Select with ▲▼
Analog Output 1
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through different modes for the selected analog output (**Off**, **Manual**, **Input**). When the desired mode appears, press **Enter** to assign that mode to the selected output.

```
Analog Outputs
Analog Output 1
Select with ▲▼
Off
```

Analog Output OFF
Select **Off** to set the selected analog output to zero volts and return to the normal display.

Analog Output Manual Mode
Select **Manual** to control output voltage from the front panel. After selecting manual mode, select unipolar or bipolar operation, then press **Enter**. Set the output value in percent with a range of -100.00% to +100.00% corresponding to -10 V to +10 V. The setting resolution is 0.01%, but actual output voltage resolution is 0.0125%. Press **Enter** again to return to the Normal display.

```
Analog Outputs
Analog Output 1
Manual Output Value
 +1.0000%
```

Analog Output Input Mode
Select **Input** to set output voltage proportional to an input reading. Several parameters associated with this mode allow flexibility. After selecting Input mode, the screen to the right appears. Use the Data Selection keys to select the sensor input (**1-8**) that the selected analog output follows. Press **Enter** when the desired input appears.

```
Analog Outputs
Analog Output 1
Select with ▲▼
Input 1
```

```
Analog Outputs
Analog Output 1
Select with ▲▼
Units K
```

```
Analog Outputs
Analog Output 1
Select with ▲▼
Bipolor Mode - Off
```

The second display in the Input mode setting sequence appears. Use the Data Selection keys to select the appropriate source for the selected sensor input:

K Kelvin temperature reading from input.
C Celsius temperature reading from input.
Sensor Sensor units reading from input.
Linear Linear equation data from input.

Press **Enter** when the desired unit appears.

The third display in the Input mode setting sequence appears. Use the Data Selection keys to turn Bipolar Mode On or Off, then press **Enter**. Bipolar allows the analog output to set a negative voltage:

On Allows a range from -10V to +10V
Off Allows a range from 0 V to +10V

The fourth display in the Input mode setting sequence appears. Use the number keys to input a value corresponding to the lowest setting of the analog output, then press **Enter**. For bipolar operation, this value corresponds to -10 V out; for unipolar operation, it corresponds to 0 V out. Resolution is 5 digits.

The fifth display in the Input mode setting sequence appears. Use the number keys to input a value corresponding to the highest setting of the analog output, 10 V, then press **Enter**. Resolution is 5 digits.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**. After setting all Input mode parameters, the normal display appears.

4.8.1 Example of Low and High Analog Parameter Setting

With the analog output set to input mode, the temperature input data and voltage output data can be related as shown in the top diagram. This setup results in a wide temperature range but sensitivity is poor. The resulting sensitivity is 0.01 V/K or 10 mV/K.

	Low		High
Input Temperature (K)	**0**	**500**	**1000**
	|---------|---------|---------|---------|---------|---------|		
Unipolar Output (V)	0	+5	+10

	Low		High
Input Temperature (K)	**50**	**75**	**100**
	|---------|---------|---------|---------|---------|---------|		
Unipolar Output (V)	0	+5	+10

Figure 4-3. Example of Low and High Analog Parameter Setting

If the application does not require a wide temperature range, the user can change the value of the low and high parameters to improve sensitivity. The bottom diagram shows how sensitivity improves when working at liquid nitrogen temperature (77 K). This setup has a narrow range with much improved sensitivity of 0.2 V/K or 200 mV/K. Please note that in any application, the resolution of the analog output voltage is always 1.25 mV as specified.

4.9 ALARMS SETUP AND OPERATION

Each input of the Model CYD218 has high and low alarm capability. Input reading data from any source can be compared to the alarm setpoint values. A reading higher than the high setpoint triggers the high alarm for that input. A reading lower than the low alarm setpoint triggers the low alarm for that input.

If an alarm activates for a particular input, the display location for that input flashes. The beeper inside the instrument can also be programmed to sound if any alarms activate. The eight relays on a CYD218S can also be tied to alarm functions as described in Paragraph 4.11.

The system Alarm annunciator steadily displays when any alarm is enabled; it flashes when any alarm activates. An input need not display for the system Alarm annunciator to indicate input alarm status.

Latching Alarms - often used to detect faults in a system or experiment that require operator intervention. The alarm state remains visible to the operator for diagnostics even if the alarm condition is removed. Relays often signal remote monitors or for added safety take critical equipment off line. Alarm Reset clears latched alarms.

Non-Latching Alarms - often tied to relay operation to control part of a system or experiment. The dead band parameter can prevent relays from turning on and off repeatedly when the sensor input reading is near an alarm setpoint. **Example:** If the high alarm setpoint = 100 K and the dead band = 1 K, the high alarm triggers when sensor input temperature increases to 100 K, and it will not deactivate until temperature drops to 99 K.

```
Alarm Setup

Select with ▲▼
Input 1
```

To begin alarm setup, press **Alarm Setup**. The display to the right appears. Use the Data Selection keys to cycle through the inputs (1-8) to set up for alarms. Press **Enter** when the desired input appears.

```
Alarm Setup
Input 1
Select with ▲▼
Alarm On
```

The second display in the setting sequence appears. Use the Data Selection keys to turn alarm operation On or Off for the selected input.

Off Disables alarm operation for the selected input. The instrument skips to the eighth display screen below.

On Enables alarm operation for the selected input and displays the third display in the setting sequence.

```
Alarm Setup
Input 1
Select with ▲▼
Units Sensor
```

The third display of the setting sequence appears, use the Data Selection keys to cycle through source selections for the selected input. There are four source options:

K	Kelvin temperature reading from input.
C	Celsius temperature reading from input.
Sensor	Sensor units reading from input.
Linear	Linear equation data from input.

Press **Enter** when the desired source appears. The next three displays involve data entry. Press Escape once to clear the entry, twice to return to the Normal display. The instrument retains values changed prior to pressing Escape twice

```
Alarm Setup
Input 1
High Alarm Point
 +0.0000V
```

The fourth display in the setting sequence appears. Use the number keys to input a high alarm setpoint in the specified units, then press **Enter**. Resolution is five digits.

```
Alarm Setup
Input 1
Low Alarm Point
 +0.0000V
```

The fifth display in the setting sequence appears. Use the number keys to input a low alarm setpoint with the specified source, then press **Enter**. Resolution is five digits.

```
Alarm Setup
Input 1
Deadband
  0.0000V
```

The sixth display in the setting sequence appears. Use the number keys to input a dead band value with the specified source, then press **Enter**. Used only with non-latching alarm. Set to 0 if not used. Resolution is five digits.

```
Alarm Setup
Input 1
Select with ▲▼
Latching Off
```

The seventh display in the setting sequence appears. Use the Data Selection keys to turn alarm latching On or Off, then press **Enter**. Latching determines whether the alarm remains active after removing the cause.

On Alarm active state is latched and remains active until **Alarm Reset** is pressed.

Off Alarm active state is not latched and clears when the alarm condition is removed.

```
Alarm Setup

Select with ▲▼
Audible Alarm Off
```

```
1  On        5 Off
2 Off        6 Off
3 Off        7 Off
4 Off        8 Off
```

The eighth display in the setting sequence appears. Use the Data Selection keys to turn the audible alarm On or Off, then press **Enter**. This is a global parameter that controls beeper operation for all input alarms.

On Beeper sounds for any active alarm on any input.

Off Beeper will not sound for any active alarm on any input.

After setting all alarm parameters, a list of the previous alarm status of all inputs momentarily displays before returning to the normal display.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

4.10 ALARM RESET

Alarm Reset resets a latched active alarm after the alarm condition has been cleared. If the alarm condition is not cleared, the alarm activates again during the next sensor input update cycle. **Alarm Reset** does not affect a non-latching alarm. After pressing **Alarm Reset**, the message to the right displays momentarily to confirm the reset.

```
Alarm Reset
```

4.11 RELAY SETUP (MODEL CYD218S ONLY)

There are eight relays on the Model CYD218S numbered 1 to 8. They are most commonly thought of as alarm relays, but may be manually controlled also. Relay assignments are configurable. A relay can be used with any input, it is not necessary for example to use relay one with input one. One relay can be assigned to activate when either alarm from a sensor input is active or two relays can be used with one sensor input for independent high and low operation.

When using relays with alarm operation, set up alarms first (Paragraph 4.9). The relays are rated for 30 VDC and 5 A. Their terminals are in the detachable terminal block on the Model CYD218S rear panel.

To begin relay setup, press **Relay Setup**. The display to the right appears. Use the Data Selection keys to cycle through the relays (1-8). Press **Enter** when the desired relay appears.

```
Relay Setup

Select with ▲▼
Relay 1
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through the relay modes. There are three relay modes:

Off Relay manually set to the normal state.
On Relay manually set to the active state.
Alarms Relay tied to alarm operation.

```
Relay Setup
Relay 1
Select with ▲▼
Mode - On
```

When the desired mode appears, press **Enter**. Select On or Off to manually set the relay state and return to the normal display. Select Alarm to tie the relay to an alarm.

The third display in the setting sequence appears. Use the Data Selection keys to cycle the sensor inputs (**1-8**) to which the relay applies. Press **Enter** when the desired input appears.

```
Relay Setup
Relay 1
Select with ▲▼
Input 1
```

The fourth display in the setting sequence appears. Use the Data Selection keys to cycle through alarms. There are three alarms:

Low Relay active only when low alarm is active.
High Relay active only when high alarm is active.
Both Relay active when high or low alarm is active.

```
Relay Setup
Relay 1
Select with ▲▼
Low Alarm
```

Press **Enter** when the desired alarm appears. The normal display appears.

Press **Escape** at any time to return to the normal display. The instrument retains values changed prior to pressing **Escape**.

4.12 LOCKING THE KEYPAD

The Model CYD218 keypad lock feature prevents accidental changes to parameter values. When the keypad is locked, some parameter values may be viewed, but most cannot be changed over the front panel. Alarm Reset is the only keypad function that remains active when the keypad is locked.

A three digit keypad lock code locks and unlocks the keypad. The factory default code is **123**. The code can be changed only through the computer interface. If instrument parameters are reset to default values, the lock code resets also. The instrument cannot reset from the front panel with the keypad locked.

To lock the keypad press and hold **Enter** for 10 seconds to display the screen to the right.

```
Enter Code To
Lock Keypad
```

Use the number keys to enter the 3-digit lock code. The keypad locks and the normal display appears. Changes attempted to any of the Model CYD218 parameters result in a brief display of the *LOCKED* message.

To unlock the keypad press and hold **Enter** for 10 seconds to display the screen to the right.

```
Enter Code To
Unlock Keypad
```

Use the number keys to enter the 3-digit lock code. The keypad unlocks and the normal display appears. All Model CYD218 parameters are now accessible.

4.13 RESETTING MODEL CYD218 TO DEFAULTS

To reset the Model CYD218 to defaults, press and hold **Escape** until the screen to the right appears.

```
      10:36:05
      08/24/98
Code Date: 08/21/98
Reset NOVRAM No
```

Use the Data Selection keys to select Yes or No to reset the NOVRAM, then press **Enter**. Select Yes to reset all Model CYD218 parameters to the defaults listed in Table 4-4 below. The second screen in the setting sequence displays.

```
      10:36:05
      08/24/98
Code Date: 08/21/98
Clear Curves No
```

Use the Data Selection keys to select Yes or No to clear all user curves stored in the Model CYD218. Standard curves are unaffected. Press **Enter**. The instrument performs the operations specified then displays the Normal display.

Table 4-4. Model CYD218 Parameter Defaults

Parameter	Default
Input Type	2.5V Diode
Input Curve	DT-470
Analog Out	Off
Relays	Off
Printer	Off
Log Mode	Off
Filter	Off
Alarms	Off
Audible Alarm	Off

Parameter	Default
Max/Min Units	K
Linear Units	K
Local/Remote	Local
Address	12
Terminators	CR/LF
Baud	9600
Keypad	Not Locked
Lock Code	123
Display	Locations 1-8 = Inputs 1-8. Source = K.

CHAPTER 5

SPECIAL FEATURES

5.0 GENERAL

This chapter covers Front Panel Curve Entry in Paragraph 5.1, SoftCal in Paragraph 5.2, Data Logging in Paragraph 5.3, and Printing in Paragraph 5.4. Most users will not find it necessary to use these special features during normal operation.

5.1 FRONT PANEL CURVE ENTRY

A unique 200 point user curve can be stored for each of the eight inputs. CalCurves for Omega Engineering calibrated sensors can be stored as user curves. The built in SoftCal algorithm (Paragraph 5.2) uses the same memory space so it is not possible to enter a user curve and SoftCal curve for the same input. User curves must be stored in the same location number as the sensor input. Once an appropriate user curve is stored for a sensor input it can be selected just like standard curves. A user curve may not be shared between multiple inputs.

Collect and format all necessary information on paper before beginning the entry process. Curve header information cannot be overlooked; it is as important to proper operation as the data breakpoints. Enter curve data breakpoints in increasing sensor units order. Other instruments use this curve data format and curve breakpoints may be entered that are beyond the Model CYD218 reading capability.

5.1.1 Curve Header Parameters

Curve Number: User curves accessed from the front panel are numbered by sensor input (**1-8**). When accessed over the computer interface, they are numbered from **21** to **28**.

Name: Defaults to the name **User Curve** for front panel entry. When entering a user curve over the computer interface, a curve name of up to 15 characters can be entered.

Serial Number: Up to a 10-character sensor serial number that displays during curve selection can be entered. Both numbers and letters can be entered over computer interface, only numbers can be entered from the front panel.

Format: The format parameter tells the instrument what breakpoint data format to expect. Different sensor types require different formats. Formats for Omega Engineering sensors are:

V/K Volts vs. Kelvin for Diode sensors.
Ω/K Resistance vs. Kelvin for platinum RTD sensors.
Log Ω/K Log Resistance vs. Kelvin for NTC resistive sensors.

Limit: Enter a temperature limit in Kelvin for the curve. Default is 375 K. Enter a setting of 9999.9 K if no limit is needed. This parameter is not used by the Model CYD218.

Temperature Coefficient: The instrument derives the temperature coefficient from the first two breakpoints. The user does not enter this setting. If it is not correct check for proper entry of those points. A positive coefficient (**P**) indicates that the sensor signal increases with increasing temperature. A negative coefficient (**N**) indicates that the sensor signal decreases with increasing temperature.

Table 5-1. Recommended Curve Parameters

Type	Model No.	Units	Format	Limit (K)	Coefficient	Recommended Sensor Resolution
Silicon Diode	CY7-SD	Volts	V/K	475	Negative	0.00001 (V)
GaAlAs Diode	TG-120	Volts	V/K	475	Negative	0.00001 (V)
Platinum 100	PT-100	Ohms	Ω/K	800	Positive	0.001 (Ω)
Platinum 1000	PT-100	Ohms	Ω/K	800	Positive	0.01 (Ω)

5.1.2 Curve Breakpoints

Reduce the temperature response data of a calibrated sensor to a table of breakpoints before entering it into the instrument. Each breakpoint consists of a value in sensor units and a corresponding temperature value in Kelvin. Linear interpolation is used by the instrument to calculate temperature between breakpoints. Enter from 2 to 200 breakpoints as a user curve. No special endpoints are required.

Setting resolution is six digits in sensor units. The sensor type determines the practical range of values. The input resolution of the instrument determines the practical resolution. Additional resolution is ignored.

Setting resolution is six digits in temperature. Enter most breakpoints with 0.001 K resolution. Enter temperatures above 1000 K with lower resolution. Enter temperatures below 10 K with 0.0001 K resolution. Increased low temperature resolution can improve the curve accuracy of NTC resistors that have increased sensitivity at low temperatures.

Enter breakpoints with the sensor units increasing with breakpoint number. Leave all unused breakpoints at zero. Leave no zero breakpoints in the middle of a user curve; they are interpreted as the end of the curve.

5.1.3 Editing an Existing Curve

Curve editing functions work for existing user curves as well as new curves. Enter the curve entry mode as described for a new curve, add or erase points as needed, then press **Enter** on the zero breakpoint to exit curve entry mode and save the changes.

To edit a breakpoint, use the Data Selection keys to scroll to the breakpoint, input the new value, then press **Enter**. If the new breakpoint is out of order, the instrument flashes a message similar to the one shown below and moves the breakpoint to the appropriate location.

```
Moving Curve Point
 to Location XXX
```

To add a breakpoint to the table, use the Data Selection keys to scroll to the end of the curve data and add the new point on the first line displayed as zero. If the new breakpoint is out of order, the instrument flashes a message similar to the one shown above and moves the breakpoint to the appropriate location.

To erase a breakpoint, use the Data Selection keys to scroll to the breakpoint, then set both sensor units and temperature values to zero. The instrument erases the point and moves following points up. To erase an entire curve, refer to Paragraph 5.1.5.

5.1.4 Entering a New Curve

To begin entering a user curve, press **Curve Entry**. The first screen appears. Use the Data Selection keys to select Edit Curve, then press Enter.

```
Curve Entry

Select with ▲▼
Edit Curve
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through the different inputs to which the curve applies (**1-8**) and standard curves. If a standard curve is selected, the curve view screen appears. Standard curves are read-only; users cannot change their parameters. When the desired input or standard curve appears, press **Enter**.

```
Curve Entry
Edit Curve
Select with ▲▼
Input 1
```

The third display in the setting sequence appears. Use the number keys to input up to a ten-digit serial number for the curve to be entered, then press **Enter**.

```
Edit Curve 1
Serial Number

3587
```

The fourth display in the setting sequence appears. Use the Data Selection keys to select the appropriate sensor format for the installed sensor. There are three formats:

V/K	Volts vs. Kelvin for Diode sensors.
Ω/K	Resistance vs. Kelvin for platinum RTD sensors.
Log Ω/K	Log Resistance vs. Kelvin for NTC resistive sensors.

```
Edit Curve 1
Curve Format
Select with ▲▼
V/K
```

When the desired format appears, press **Enter**. Refer to Table 5-1 for recommended formats for specific sensors.

The fifth display in the setting sequence appears. Use the number keys to input an appropriate upper temperature limit for the installed sensor, then press **Enter**. Refer to Table 5-1 for recommended temperature limits for specific sensors.

```
Edit Curve 1
Upper Temp. Limit

  475.00K
```

The final display in the setting sequence appears. Use the number keys to input individual breakpoint pairs of the curve. Press **Enter** both after inputting the sensor units and the temperature.

```
Curve Entry 1:001


01:0.09062V 475.000K
```

After entry of a breakpoint pair, the instrument displays a zero breakpoint. Enter up to 200 breakpoints. To exit the curve entry mode and store the new curve, press **Enter** on a new breakpoint line. To enter a zero sensor units value, press zero before pressing **Enter**. The curve stores, but users must select it for the appropriate input before it is used.

NOTE: Escape returns a single setting to its previous value. It cannot return a complete breakpoint or an entire curve to a previous state.

Use the Data Selection keys to scroll up or down the breakpoint table. Only the breakpoint located at the bottom line of the display is active for entry or editing.

5.1.5 Erasing User Curves

To erase a user curve, press **Curve Entry**. The screen to the right appears.

```
Curve Entry

Select with ▲▼
Edit Curve
```

Use the Data Selection keys to select **Erase Curve**, then press **Enter**. The second display in the sequence appears.

```
Curve Entry
Erase Curve
Select with ▲▼
Input 1
```

Use the Data Selection keys to cycle to the input to which the curve applies (**1-8**). When the desired input appears, press **Enter**. The final display in the sequence appears.

```
Curve Entry
Erase Curve Input 1
Press Enter to erase
Press Esc. to cancel
```

Press **Enter** to delete the specified curve and return to the normal display. Press **Escape** to cancel the deletion and return to the normal display.

5.1.6 Viewing Standard Curves

View standard curves using the curve entry procedure. Standard curves are read-only (uneditable).

5.1.7 Copying Curves

Temperature curves can be copied from one location inside the Model CYD218 to another. This is a good way to make small changes to an existing curve. Curve copy may also be necessary if the user needs the same curve with two different temperature limits or needs to extend the range of a standard curve. The curve that is copied from is always preserved.

NOTE: The copy routine allows you to overwrite an existing user curve. Please ensure the curve number you are writing to is correct before proceeding with curve copy.

To copy a curve, press the **Curve Entry** key. Press the ▲ or ▼ key until you see the following display.

```
Curve Entry

Select With ▲▼
Copy Curve
```

Press the **Enter** key. You can press the **Escape** key anytime during this routine to return to the normal display.

Copying Curves (Continued)

```
Curve Entry
Copy Curve from
Select With ▲▼
DT-470
```

Use the ▲ or ▼ key to select the curve number to copy from. Once the curve number is selected, press the **Enter** key. You will see the following message.

```
Curve Entry
Copy Curve to
Select With ▲▼
Input 1 User
```

Use the ▲ or ▼ key to select the input number (1 thru 8) of the curve to copy to. Press the **Enter** key to copy the curve. You now return to the normal display.

5.2 SOFTCAL™

The Model CYD218 performs inexpensive sensor calibrations with two algorithms called SoftCal. These algorithms work with DT-400 Series Silicon Diode sensors and Platinum Sensors. They create a new temperature response curve from the standard curve and known data points entered by the user. The new curve loads into one of the eight user curve locations. These paragraphs describe the data points needed from the user and the expected accuracy of the resulting curves.

Both DT-400 and Platinum SoftCal algorithms use an existing standard curve in the Model CYD218. The new curve will be named SCAL DT # or SCAL PT #. When calibration is complete, the user must select the new curve for the input; the Model CYD218 does not automatically choose the newly generated curve for any input.

Each algorithm operates with one, two, or three calibration points. The range of improved accuracy increases with more points. The calibration points are normally measured at easily reached temperatures like the boiling point of cryogens.

The way to get SoftCal calibration data points is: the user records the response of an unknown sensor at well controlled temperatures.

- **User:** When the user can provide stable calibration temperatures with the sensor installed, SoftCal calibration eliminates errors in the sensor measurement as well as the sensor. Thermal gradients, instrument accuracy, and other measurement errors can be significant. Calibration can be no better than user-supplied data.

5.2.1 SoftCal and Silicon Diode Sensors

Silicon Diode Sensors incorporate remarkably uniform sensing elements that exhibit precise, monotonic, and repeatable temperature response. For example, the CYD Series of silicon diode sensors has a repeatable temperature response from 2 K to 475 K. These sensors closely follow the Standard Curve 10 response and are interchangeable. SoftCal is an inexpensive way to improve the accuracy of an already predictable sensor.

NOTE: Standard Curve 10 is the name of the temperature response curve, not its location inside the Model CYD218. Standard Curve 10 stores in Curve Location #1 in the Model CYD218 under the name "CY7-SD".

A unique characteristic of DT-400 Series diodes is that their temperature responses pass through 28 K at almost exactly the same voltage. This knowledge improves SoftCal operation by providing an extra calibration data point. It also explains why SoftCal calibration specifications are divided into two temperature ranges, above and below 28 K. See Figure 5-1.

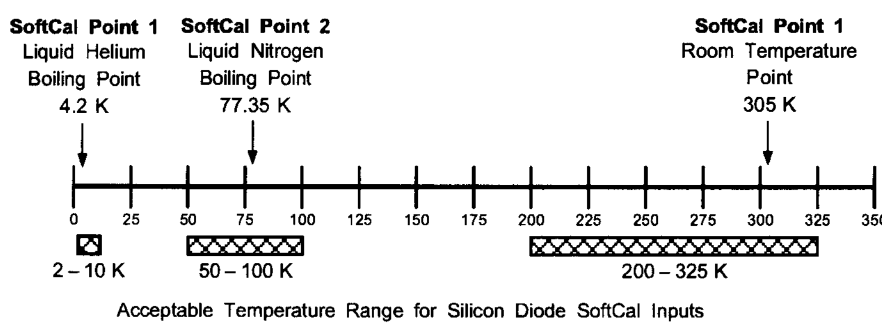


Figure 5-1. SoftCal Temperature Ranges for Silicon Diode Sensors

Point 1: Calibration data point at or near the boiling point of helium, 4.2 K. Temperatures outside 2 K to 10 K are not allowed. This data point improves accuracy between the calibration data point and 28K. Points 2 and 3 improve temperatures above 28 K.

Point 2: Calibration data point at or near the boiling point of nitrogen (77.35 K). Temperatures outside 50 K to 100 K are not allowed. This data point improves accuracy between 28 K and 100 K. Points 2 and 3, together, improve accuracy to room temperature and above.

Point 3: Calibration data point near room temperature (305 K). Temperatures outside the range of 200 K to 350 K are not allowed.

5.2.2 SoftCal Accuracy with Silicon Diode Sensors

NOTE: A SoftCal calibration is only as good as the accuracy of the calibration points. The accuracies listed for SoftCal assume ±0.05 K for 77.35 K (liquid nitrogen) and 305 K (room temperature) points, and ±0.01 K for 4.2 K (liquid helium). Users performing the SoftCal with silicon diodes and Omega Engineering instruments should note that liquefied nitrogen and ice point temperatures can vary as much as ±0.5 K. Use a calibrated standard sensor if possible. The boiling point of liquid helium, though quite accurate, is affected by atmospheric pressure.

One-point SoftCal calibrations for applications under 30 K are performed at liquid helium (4.2 K). Resultant accuracy for the CYD SD7 diode is:

±0.5 K from 2 K to <30 K (no change above 30 K)

Two-point SoftCal calibrations for applications above 30 K are performed at liquid nitrogen (77.35 K) and room temperature (305 K). Resultant accuracy for the CY7-SD-SD-13 diode sensor is:

±1.0 K from 2 K to <30 K (no change below 30 K)	
±0.25 K from 30 K to <60 K	±0.25 K from 345 K to <375 K
±0.15 K from 60 K to <345 K	±1.0 K from 375 to 475 K

Three-point SoftCal calibrations are performed at liquid helium (4.2 K), liquid nitrogen (77.35 K), and room temperature (305 K). Resultant accuracy for the CY7-SD-SD-13 diode sensor is:

±0.5 K from 2 K to <30	
±0.25 K from 30 K to <60 K	±0.25 K from 345 K to <375 K
±0.15 K from 60 K to <345 K	±1.0 K from 375 to 475 K

5.2.3 SoftCal and Platinum Sensors

The platinum sensor is a well-accepted temperature standard because of its consistent and repeatable temperature response above 30 K. SoftCal gives platinum sensors better accuracy than their nominal matching to the DIN 43760 curve.

One, two, or three calibration data points can be used. If using 1 point, the algorithm shifts the entire curve up or down to meet the single point. If using 2 points, the algorithm has enough information to tilt the curve, achieving good accuracy between the data points. The 3rd point extends the improved accuracy across all three points.

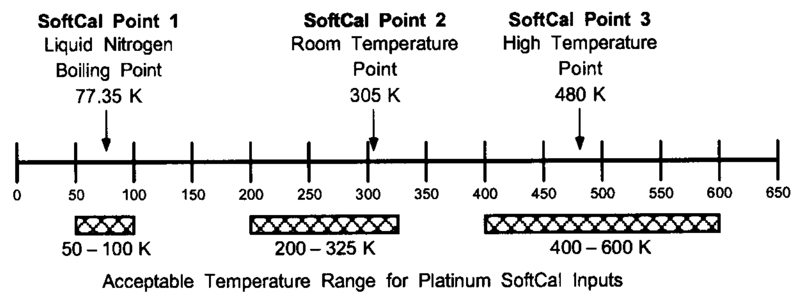


Figure 5-2. SoftCal Temperature Ranges for Platinum Sensors

Point 1: Calibration data point at or near the boiling point of nitrogen (77.35 K). Temperatures outside 50 K to 100 K are not allowed.
Point 2: Calibration data point near room temperature (305 K). Temperatures outside 200 K to 350 K are not allowed.
Point 3: Calibration data point at a higher temperature (480 K). Temperatures outside 400 K to 600 K are not allowed.

5.2.4 SoftCal Accuracy with Platinum Sensors

NOTE: A SoftCal calibration is only as good as the accuracy of the calibration points. The accuracies listed for SoftCal assume ±0.05 K for 77.35 (liquid nitrogen) K and 305 K (room temperature) points. Users performing a SoftCal with Omega Engineering instrumentation should note that liquefied nitrogen and ice point temperatures can vary as much as ±0.5 K. Use a calibrated standard sensor if possible.

One-point SoftCal calibrations with platinum sensors have no specified accuracy.

Two-point SoftCal calibrations for applications above 70 K are performed at liquid nitrogen (77.35 K) and room temperature (305 K). Accuracy for the PT-102, PT-103, or PT-111 platinum sensor is:

±250 mK from 70 K to 325 K	≈±500 mK from 325 K to ≈±1400 mK at 480 K (DIN Class A or Class B tolerance)

Three-point SoftCal calibrations are performed at liquid nitrogen (77.35 K), room temperature (305 K), and high temperature (480 K). Accuracy for the PT-102, PT-103, or PT-111 platinum sensor is:

±250 mK from 70 K to 325 K	±250 mK from 325 K to 480 K.

5.2.5 Creating a SoftCal Calibration Curve

```
SoftCal
Standard Curve
Select with ▲▼
DT-470
```

Obtain calibration data points. Press **SoftCal**. The display to the right appears. Use the Data Selection keys to cycle through the curves to use as a basis for calibration. Press **Enter** when the desired curve appears.

```
SoftCal
Storage Location
Select with ▲▼
Input 1
```

The second display in the setting sequence appears. Use the Data Selection keys to cycle through the inputs where the new SoftCal curve stores. Press **Enter** when the desired input appears.

CAUTION: If a user curve already exists at the input location, the instrument overwrites it with the new SoftCal user curve.

```
SoftCal
Serial Number
```

The third display in the setting sequence appears. Use the number keys to input up to a ten-digit serial number, then press **Enter**.

```
SoftCal
Input 1
Point 1
1.62622V        4.2000K
```

The fourth display in the setting sequence appears. Use the number keys to input the voltage or resistance of the first calibration data point, then press **Enter**. Use the number keys to input the temperature in Kelvin that corresponds to the voltage or resistance of the first calibration data point, then press **Enter**. Points outside acceptable range will not be allowed. If the first point is not used, press **Enter** twice without entering any data.

```
SoftCal
Input 1
Point 2
1.02032V       77.3500K
```

The fifth display in the setting sequence appears. Use the number keys to input the voltage or resistance of the second calibration data point, then press **Enter**. Use the number keys to input the temperature in Kelvin that corresponds to the voltage or resistance of the second calibration data point, then press **Enter**. If the second point is not used, press **Enter** twice without entering any data.

```
SoftCal
Input 1
Point 3
0.50691V       305.000K
```

The sixth display in the setting sequence appears. Use the number keys to input the voltage or resistance of the third calibration data point, then press **Enter**. Use the number keys to input the temperature in Kelvin that corresponds to the voltage or resistance of the third calibration data point, then press **Enter**. The Model CYD218 creates and stores the SoftCal curve, but users must select the curve for the appropriate input before it is used. If the third point is not used, press **Enter** twice without entering any data.

Press **Escape** at anytime to cancel the SoftCal creation sequence and return to the normal display.

5.3 DATA LOGGING

The Model CYD218 has internal memory reserved for data logging. Reading data can be stored in the instrument to be printed or read over computer interface at a later time. Data log setup parameters can also be used to control printer operation. Active data logging and active printing cannot occur at the same time.

Data is taken in groups called records. Up to eight readings can be logged or printed as one record. Readings can be from any input and any source. Each record includes a time stamp. The Model CYD218 dedicates 12 Kbytes of memory to data logging. Table 5-2 indicates the maximum number of records that can be stored based on the number of readings in a record.

Table 5-2 Storage Capability Based on Readings per Record

Records	Readings
1500	1
1000	2
750	3
600	4
500	5
425	6
375	7
340	8

5.3.1 Log Setup

NOTE: Changing Log Setup will erase stored records.

To setup the data log function, press **Log Setup**. The first screen in the setting sequence appears. Use the Data Selection keys to cycle through the different log modes listed below. When the desired mode appears, press **Enter**.

```
Log Setup
Mode
Select with ▲▼
Log Continuous
```

Off Disables Log functions. Log On/Off will not initiate logging, and current logging stops. Selecting Off displays the Set Time screen next (see below).

Log Continuous Logs data to internal memory at regular intervals.

Log Event Logs to internal memory only when an input configured for logging goes into or comes out of an alarm or error condition.

Print Continuous Sends data to printer using data log setup parameters. Sends one record at a time with a minimum of 10 seconds between records.

Print Event Similar to Log Event. The instrument sends data to the printer instead of logging it to internal memory.

```
Log Setup
Overwrite Data
Select with ▲▼
Yes
```

The second display in the setting sequence appears. Use the Data Selection keys to specify the Overwrite status listed below. When the desired status appears, press **Enter**.

Yes Data logging continues beyond the maximum number of records specified and overwrites old records with new.

No Data logging stops at the maximum number of records specified.

```
Log Setup
Start Mode
Select with ▲▼
Continue
```

The third display in the setting sequence appears. Use the Data Selection keys to specify the Start Mode listed below. When the desired mode appears, press **Enter**.

Clear **Log On** command clears old records before new data is logged.

Continue **Log On** command continues data logging and adds new records to existing data.

```
Log Setup
Log Period

0001 Seconds
```

```
Log Setup
Number of Readings
Select with ▲▼
1
```

The fourth display in the setting sequence appears. Use the number keys to input the period in seconds (**1 to 3600**) between data log records, then press **Enter**. Ten second minimum if logging operates in print mode.

NOTE: Continuous polling of the instrument over the computer interface can affect the log period.

The fifth display in the setting sequence appears. Use the Data Selection keys to select the number of readings per record (**1-8**).

The sixth display in the setting sequence appears. Use the Data Selection keys to specify the input from which to take readings (**1-8**). When the desired input appears, press **Enter**.

```
Log Setup
Location 1
Select with ▲▼
Input 1
```

The next display in the setting sequence appears. Use the Data Selection keys to select the appropriate source for the selected sensor input:

K Kelvin temperature reading from input.
C Celsius temperature reading from input.
Sensor Sensor units reading from input.
Linear Linear equation data from input.

```
Log Setup
Location 1
Select with ▲▼
Units K
```

Press **Enter** when the desired source appears. The number of source selection screens that follow depends on the number of readings selected.

The eighth display in the setting sequence appears. Use the number keys to input the time of day in hours (**01-24**), minutes (**01-60**), and seconds (**01-60**). After inputting the correct time, press **Enter**.

```
Log Setup
Set Time
HH:MM:SS
15:33:30
```

The final display in the setting sequence appears. Use the number keys to input the date in month (**01-12**), day (**01-31**), year (**00-99**) format. After inputting the date, press **Enter**.

```
Log Setup
Set Date
MM/YY/DD
07/06/98
```

NOTE: The Model CYD218 is Y2K compliant.

5.3.2 Starting and Stopping Data Log

The **Log On/Off** key is used to start and stop data logging. The start and overwrite parameters set with **Log Setup** determine the operation of **Log On/Off** key.

If start is set to clear, the **Log On/Off** key will first clear the data buffer of old records and then begin the log sequence. Pressing **Log On/Off** again will stop the log sequence so data can be viewed or printed. If overwrite is set to no, the log sequence will stop automatically at the end of the data buffer. If overwrite is set to yes, new records will continue to overwrite old ones until the sequence is stopped. Whichever method stops the log sequence, all logged data will be lost when the a new log sequence is begun.

If start is set to continue, the **Log On/Off** key will begin the log sequence at the end of the old records. Pressing **Log On/Off** again will stop the sequence. If overwrite is set to no, the log sequence will stop automatically at the end of the data buffer. If overwrite is set to yes, new records will continue to overwrite old ones until the sequence is stopped.

With logging active, the Data Log (**D**) annunciator displays. If overwrite is set to No, the (**D**) annunciator will turn off when the end of the data buffer is reached.

5.3.3 Viewing Logged Data

To view logged records, first turn off logging with the **Log On/Off** key, then press **Log View**. If logging is active when Log View is pressed, logging pauses while data is viewed and resumes after Log View is exited.

```
0001:  10:15:05 07/08
   1 253.15K  T
0002:  10:15:15 07/08
   1 245.68K  H
```

When viewing logged records, the screen shown to the right displays. The data log screen includes a record number, time, date, and the readings specified in the log setup. The instrument tags any readings in which an alarm or error occurs with alarm/error designations listed below.

L Low Alarm
H High Alarm
B Both Alarms
T Temperature Over or Under Range
S Sensor Over or Under Range

Use the Data Selection keys to scroll up and down. Scrolling up past the first record will show the last record.

5.3.4 Line Power Loss

Data log memory is non-volatile and will not erase when line power is lost. The Model CYD218 cannot log data while power is off, but it resumes the data log sequence when power is restored. Date and time are also non-volatile and do not have to be entered after power loss.

5.4 PRINTING

The Model CYD218 can send sensor input data to a printer for a hard copy temperature record. The serial port interfaces with standard printers. The serial computer interface and a printer cannot be used at the same time. Some printer operating parameters are shared with the data log feature. It is important to setup data log before trying to print.

Table 5-3. Serial Printer Interface Specifications

Configuration:	DTE
Connector:	DE-9P
Timing Format:	Asynchronous
Parity:	None
Data Interface Levels:	Transmits and receives using EIA voltage levels.
Baud Rate:	9600
Data Bits:	8
Start/Stop Bits:	1

5.4.1 Printer Support

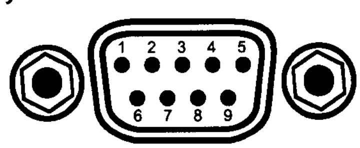
Serial printers connected directly to the Model CYD218 must have a serial interface port and should be Epson or HP compatible and support ASCII text mode. Continuous feed printers are recommended for all print modes. Single sheet feed printers are recommended for printing stored logs only. A minimum print speed of 15 characters per second is required.

For typical serial printer operation, DTR is the preferred method of handshaking. Under DTR, the printer maintains a HIGH signal when ready to receive Model CYD218 data. The signal drops to LOW when the printer suspends the flow of data. If a printer uses a different lead for flow control (4, 11, 19, or 25), connect that lead to pin 6 (DSR in) of the CYD218 serial connector. Check printer users manual for more information.

5.4.2 Printer Connector & Cable

For most serial printers, a standard PC to printer cable may be used.

Pin	Description
1	No Connection (NC)
2	Receive Data (RD in)
3	Transmit Data (TD out)
4	Data Terminal Ready (DTR out)
5	Ground (GND)
6	Data Set Ready (DSR in)
7	Data Terminal Ready (DTR out) (tied to 4)
8	No Connection (NC)
9	No Connection (NC)



NOTE: A "P" at the end of a connector description indicates a male connector; an "S" indicates a female connector.

CYD218 to Serial Printer (Printer with DB-25S/P)

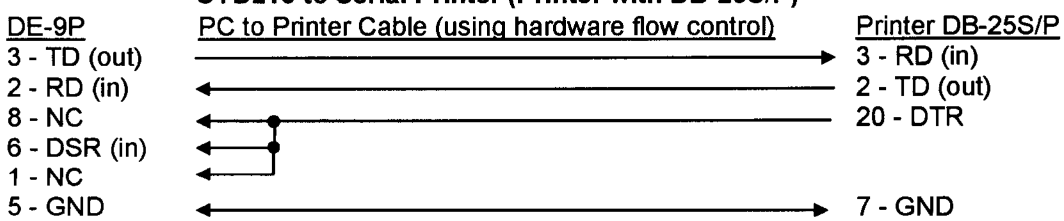


Figure 5-3. Serial Port Pinouts

5.4.3 Printer Operation

To print with the Model CYD218, first connect the serial port to a serial printer, then press **Printer**. The screen shown to the right displays. The Model CYD218 printer function has three operating modes. Printer function can also be turned off, freeing the port for serial interface operation. Printer modes are:

```
Printer

Select with ▲▼
Off
```

Off No printer operation (serial I/O enabled).

Print Stored Log Prints the contents of data log memory to the printer. The data log feature is described in section 5.3. Once the data log sequence completes, all stored records can print. Printing the entire contents of memory may take up to 40 pages. Normal sensor reading operation suspends during printing.

Print Continuous Directs log records to the printer instead of internal memory. Setup the data log feature as described in paragraph 5.3.1 The log period must be greater than 10 seconds when printing. If log period is set to a value below 10, the instrument prints a log record every 10 seconds.

NOTE: When using Print Continuous, small delays in log period may occur (up to approximately 120 ms per printed record). For time critical applications Log Continuous mode is recommended.

Print Event Directs log records to the printer instead of internal memory when an input alarm or an error event either occurs or is removed. No period is set by user. The instrument checks for an event every 10 seconds and prints if one exists. If an event occurs and then is removed within the 10 second window, it will not print.

Use the Data Selection keys to cycle through the different modes. When the desired mode appears, press **Enter** to activate that mode.

Select Print Stored Log to print data immediately. The screen to the right displays. To stop printing at any time and return to the normal display, press **Escape**.

```
Printing...
```

If the mode is Print Continuous or Print Event, use the Log On/Off key to start and stop printing. With Print Continuous or Print Event selected, only the Data Log (**D**) annunciator displays during printing.

The data log prints in the format below:

```
MM/DD/YY HH:MM:SS 1:+123.45US 2:+123.45US 3:+123.45US 4:+123.45US
                  5:+123.45US 6:+123.45US 7:+123.45US 8:+123.45US
```

MM/DD/YY = Month/Day/Year HH/MM/SS = Hour/Minutes/Seconds

U (Units) =	**K**	Kelvin	S (Status) =	**L**	Low Alarm
	C	Celsius		**H**	High Alarm
	V	Volts		**B**	Both Alarms
	R	Ohms		**T**	Temperature Over or Under Range
	L	Linear		**S**	Sensor Over or Under Range

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CHAPTER 6

REMOTE OPERATION

6.0 GENERAL

This chapter provides operational instructions for the computer interface for the Model CYD218 Temperature Monitor. Either of the two computer interfaces provided with the Model CYD218 permit remote operation. The first is the IEEE-488 Interface described in Paragraph 6.1. The second is the Serial Interface described in Paragraph 6.2. The two interfaces share a common set of commands detailed in Paragraph 6.3. Only one of the interfaces can be used at a time.

6.1 IEEE-488 INTERFACE

The IEEE-488 Interface is an instrumentation bus with hardware and programming standards that simplify instrument interfacing. The Model CYD218 IEEE-488 Interface complies with the IEEE-488.2-1987 standard and incorporates its functional, electrical, and mechanical specifications unless otherwise specified in this manual.

All instruments on the interface bus perform one or more of the interface functions of TALKER, LISTENER, or BUS CONTROLLER. A TALKER transmits data onto the bus to other devices. A LISTENER receives data from other devices through the bus. The BUS CONTROLLER designates to the devices on the bus which function to perform. The Model CYD218 performs the functions of TALKER and LISTENER but cannot be a BUS CONTROLLER. The BUS CONTROLLER is the digital computer which tells the Model CYD218 which functions to perform.

Below are Model CYD218 IEEE-488 interface capabilities:

- **SH1:** Source handshake capability.
- **RL1:** Complete remote/local capability.
- **DC1:** Full device clear capability.
- **DT0:** No device trigger capability.
- **C0:** No system controller capability.
- **T5:** Basic TALKER, serial poll capability, talk only, unaddressed to talk if addressed to listen.
- **L4:** Basic LISTENER, unaddressed to listen if addressed to talk.
- **SR1:** Service request capability.
- **AH1:** Acceptor handshake capability.
- **PP0:** No parallel poll capability.
- **E1:** Open collector electronics.

6.1.1 IEEE-488 Interface Settings

If using the IEEE-488 interface, you must set the IEEE Address and Terminators. Press the **Interface** key. The first screen selects Serial Interface Baud Rate, and therefore is skipped by pressing the **Enter** key. The Address screen is then displayed.

```
IEEE-488 I/O Setup

Select with ▲▼
Address 12
```

Press the ▲ or ▼ keys to increment or decrement the IEEE Address to the desired number. Press **Enter** to accept new number or **Escape** to retain the existing number. Pressing **Enter** displays the Terminators screen.

IEEE-488 Interface Settings (Continued)

```
IEEE-488 I/O Setup

Select with ▲▼
Term   Cr Lf
```

Press the ▲ or ▼ keys to cycle through the following Terminator choices: CR/LF, LF/CR, LF, and EOI. To accept changes or the currently displayed setting, push **Enter**. To cancel changes, push **Escape**. Power down the Model CYD218 then back up again to allow other devices on the IEEE-488 bus to recognize a new Address or Terminator setting.

6.1.2 IEEE-488 Command Structure

The Model CYD218 supports several command types. These commands are divided into three groups.

1. **Bus Control** – Refer to Paragraph 6.1.2.1.
   - **a.** Universal
     - (1) Uniline
     - (2) Multiline
   - **b.** Addressed Bus Control
2. **Common** – Refer to Paragraph 6.1.2.2.
3. **Interface** and **Device Specific** – Refer to Paragraph 6.1.2.3.

6.1.2.1 Bus Control Commands

A Universal Command addresses all devices on the bus. Universal Commands include Uniline and Multiline Commands. A Uniline Command (Message) asserts only a single signal line. The Model CYD218 recognizes two of these messages from the BUS CONTROLLER: **Remote (REN)** and **Interface Clear (IFC)**. The Model CYD218 sends one Uniline Command: **Service Request (SRQ)**.

REN (Remote) – Puts the Model CYD218 into remote mode.

IFC (Interface Clear) – Stops current operation on the bus.

SRQ (Service Request) – Tells the bus controller that the Model CYD218 needs interface service.

A Multiline Command asserts a group of signal lines. All devices equipped to implement such commands do so simultaneously upon command transmission. These commands transmit with the Attention (ATN) line asserted low. The Model CYD218 recognizes two Multiline commands:

LLO (Local Lockout) – Prevents the use of instrument front panel controls.

DCL (Device Clear) – Clears Model CYD218 interface activity and puts it into a bus idle state.

Finally, Addressed Bus Control Commands are Multiline commands that must include the Model CYD218 listen address before the instrument responds. Only the addressed device responds to these commands. The Model CYD218 recognizes three of the Addressed Bus Control Commands:

SDC (Selective Device Clear) – The SDC command performs essentially the same function as the DCL command except that only the addressed device responds.

GTL (Go To Local) – The GTL command is used to remove instruments from the remote mode. With some instruments, GTL also unlocks front panel controls if they were previously locked out with the LLO command.

SPE (Serial Poll Enable) and **SPD (Serial Poll Disable)** – Serial polling accesses the Service Request Status Byte Register. This status register contains important operational information from the unit requesting service. The SPD command ends the polling sequence.

6.1.2.2 Common Commands

Common Commands are addressed commands which create commonalty between instruments on the bus. All instruments that comply with the IEEE-488 1987 standard share these commands and their format. Common commands all begin with an asterisk. They generally relate to "bus" and "instrument" status and identification. Common query commands end with a question mark (?). Model CYD218 common commands are detailed in Paragraph 6.3 and summarized in Table 6-5.

6.1.2.3 Interface and Device Specific Commands

Device specific commands are addressed commands. The Model CYD218 supports a variety of device specific commands to program instruments remotely from a digital computer and to transfer measurements to the computer. Most device specific commands perform functions also performed from the front panel. Model CYD218 device specific commands are detailed in Paragraphs 6.3.2 thru 6.3.4 and summarized in Table 6-5.

6.1.3 Status Registers

There are two status registers: the Status Byte Register described in Paragraph 6.1.3.1, and the Standard Event Status Register in Paragraph 6.1.3.2.

6.1.3.1 Status Byte Register and Service Request Enable Register

The Status Byte Register is a single byte of data containing 6 bits of information about Model CYD218 status.

STATUS BYTE REGISTER FORMAT

Bit –	7	6	5	4	3	2	1	0
Weighting –	128	64	32	16	8	4	2	1
Bit Name –	DLOG Done	SRQ	ESB	Error	Alarm	OVLD	Not Used	New RDG

If the Service Request is enabled, any of these bits being set will cause the Model CYD218 to pull the SRQ management low to signal the BUS CONTROLLER. These bits are reset to zero upon a serial poll of the Status Byte Register. These reports can be inhibited by turning their corresponding bits in the Service Request Enable Register to off.

The Service Request Enable Register allows the user to inhibit or enable any of the status reports in the Status Byte Register. The *SRE command is used to set the bits. If a bit in the Service Request Enable Register is set (1), then that function is enabled. Refer to the *SRE command discussion.

Data Log Done, Bit (7) – This bit is set when data log is completed.

Service Request (SRQ) Bit (6) – Determines whether the Model CYD218 is to report via the SRQ line and six bits determine which status reports to make. If bits 0, 2, 3, 4, 5, or 7 are set, then the corresponding bit in the Status Byte Register is set. The Model CYD218 produces a service request only if bit 6 of the Service Request Enable Register is set. If disabled, the Status Byte Register can still be read by the BUS CONTROLLER by means of a serial poll (SPE) to examine the status reports, but the BUS CONTROLLER will not be interrupted by the Service Request. The *STB common command reads the Status Byte Register but will not clear the bits. It must be understood that certain bits in the Status Byte Register continually change.

Bits 0-5 and 7 remain latched until the Status Byte Register is read. The bit assignments are discussed below as they pertain to the Status Byte Register. These reports can only be made if they have been enabled in the Service Request Enable Register.

Standard Event Status (ESB) Bit (5) – When bit 5 is set, it indicates if one the bits from the Standard Event Status Register has been set. (Refer to Paragraph 6.1.3.2.)

Error, Bit (4) – This bit is set when there is an instrument error not related to the bus.

Alarm, Bit (3) – This bit is set when there is an alarm condition.

Overload, Bit (2) – This bit is set when any input is in either SOVER, TOVER, SUNDER, or TUNDER.

New Reading, Bit (0) – New data is available from at least one of the inputs.

6.1.3.2 Standard Event Status Register and Standard Event Status Enable Register

The Standard Event Status Register supplies various conditions of the Model CYD218.

STANDARD EVENT STATUS REGISTER FORMAT

Bit –	7	6	5	4	3	2	1	0
Weighting –	128	64	32	16	8	4	2	1
Bit Name –	PON	Not Used	CME	EXE	DDE	QYE	Not Used	OPC

Bits 2 and 6 are not used. The user will only be interrupted with the reports of this register if the bits have been enabled in the Standard Event Status Enable Register and if bit 5 of the Service Request Enable Register has been set.

The Standard Event Status Enable Register allows the user to enable any of the Standard Event Status Register reports. The Standard Event Status Enable command (∗ESE) sets the Standard Event Status Enable Register bits. If a bit of this register is set, then that function is enabled. To set a bit, send the command ∗ESE with the bit weighting for each bit you want to be set added together. Refer to the ∗ESE command discussion for further details.

The Standard Event Status Enable Query, ∗ESE?, reads the Standard Event Status Enable Register. ∗ESR? reads the Standard Event Status Register. Once this register has been read, all of the bits are reset to zero.

Power On (PON) Bit (7) – Set to indicate an instrument off-on transition.

Command Error (CME) Bit (5) – If bit 5 is set, a command error has been detected since the last reading. This means that the instrument could not interpret the command due to a syntax error, an unrecognized header, unrecognized terminators, or an unsupported command.

Execution Error (EXE) Bit (4) – If bit 4, the EXE bit is set, an execution error has been detected. This occurs when the instrument is instructed to do something not within its capabilities.

Device Dependent Error (DDE) Bit (3) – A device dependent error has been detected if the DDE bit is set. The actual device dependent error can be found by executing the various device dependent queries.

Query Error (QYE) Bit (2) – The QYE bit indicates a query error. It occurs rarely and involves loss of data because the output queue is full.

Operation Complete (OPC) Bit (0) – This bit is generated in response to the ∗OPC common command. It indicates when the Model CYD218 has completed all selected pending operations.

6.1.4 Example IEEE Setup and Program

Below is an example of how to setup and run a simple program using the built-in Model CYD218 IEEE-488 Interface. While it does not reflect every hardware/software configuration found in the field, it is representative of the overall procedure. This example uses the National Instruments GPIB - PCII/IIA card and QuickBasic 4.0 or 4.5 on a PC compatible.

6.1.4.1 GPIB Board Installation

1. Install GPIB-PCII/IIA card using National Instruments instructions.
2. Install NI-488.2 software (for DOS). Version 2.1.1 was used for the example.
3. Verify that config.sys contains the command: device = \gpib-pc\gpib.com.
4. Reboot the computer.
5. Run IBTEST to test software configuration. Do not install the instrument before running IBTEST.
6. Run IBCONF to configure the GPIB - PCII/IIA board and dev 12. Set the EOS byte to 0AH. See Figure 6-1. IBCONF modifies gpib.com.
7. Connect the instrument to the interface board and power up the instrument. Verify address is 12 and terminators are CR LF.

6.1.4.2 Running The Example QuickBasic Program

1. Copy c:\gpib-pc\Qbasic\qbib.obj to the QuickBasic directory (QB4).
2. Change to the QuickBasic directory and type: link /q qbib.obj,,,bqlb4x.lib; where x = 0 for QB4.0 and 5 for QB4.5 This one-time only command produces the library file qbib.qlb. The procedure is found in the National Instruments QuickBasic readme file Readme.qb.
3. Start QuickBasic. Type: qb /l qbib.qlb. Start QuickBasic in this way each time the IEEE interface is used to link in the library file.
4. Create the IEEE example interface program in QuickBasic. Refer to Table 6-1. Name the file "ieeeexam.bas" and save.
5. Run the program.

6.1.5 Notes On Using the IEEE Interface

- To chain commands or queries together, insert a semi-colon (;) between them. Multiple queries cannot be chained. The Model CYD218 responds to the last query entered when addressed as a talker.
- Queries generally use the same syntax as an associated setting command followed by a question mark. They most often return the same information that is sent. Some queries have no command form.
- The term **free field** indicates that the decimal point is a floating entity and can be placed at any appropriate place in the string of digits.
- Leading zeros and zeros following a decimal point are unneeded in a command string, but they are sent in response to a query. A leading "+" is not required, but a leading "–" *is* required.
- **[term]** indicates where the user places terminating characters or where they appear on a returning character string from the Model CYD218.

Table 6-1. Sample BASIC IEEE-488 Interface Program

```
'       IEEEEXAM.BAS     EXAMPLE PROGRAM FOR IEEE-488 INTERFACE
'       This program works with QuickBasic 4.0/4.5 on an IBM PC or compatible.
'       The example requires a properly configured National Instruments GPIB-PC2 card.  The REM
'       $INCLUDE statement is necessary along with a correct path to the file QBDECL.BAS.
'       CONFIG.SYS must call GPIB.COM created by IBCONF.EXE prior to running Basic.  There must
'       be QBIB.QBL library in the QuickBasic Directory and QuickBasic must start with a link
'       to it.  All instrument settings are assumed to be defaults: Address 12, Terminators
'       <CR> <LF> and EOI active.
'
'       To use, type an instrument command or query at the prompt. The computer transmits to
'       the instrument and displays any response. If no query is sent, the instrument responds
'       to the last query received. Type "EXIT" to exit the program.
'
        REM $INCLUDE: 'c:\gpib-pc\qbasic\qbdecl.bas'         'Link to IEEE calls
        CLS                                                   'Clear screen
        PRINT "IEEE-488 COMMUNICATION PROGRAM"
        PRINT
        CALL IBFIND("dev12", DEV12%)                          'Open communication at address 12
        TERM$ = CHR$(13) + CHR$(10)                           'Terminators are <CR><LF>

LOOP2:  IN$ = SPACE$(2000)                                    'Clear for return string

        LINE INPUT "ENTER COMMAND (or EXIT):"; CMD$           'Get command from keyboard
        CMD$ = UCASE$(CMD$)                                   'Change input to upper case
           IF CMD$ = "EXIT" THEN END                          'Get out on Exit
        CMD$ = CMD$ + TERM$
        CALL IBWRT(DEV12%, CMD$)                              'Send command to instrument
        CALL IBRD(DEV12%, IN$)                                'Get data back each time
        ENDTEST = INSTR(IN$, CHR$(13))                        'Test for returned string
           IF ENDTEST > 0 THEN                                'String is present if <CR> is seen
              IN$ = MID$(IN$, 1, ENDTEST - 1)                 'Strip off terminators
              PRINT "RESPONSE:", IN$                          'Print return string
           ELSE
              PRINT "NO RESPONSE"                             'No string present if timeout
           END IF
        GOTO LOOP2                                            'Get next command
```

```
National Instruments          GPIB0 Configuration       GPIB-PC2/2A Ver 2.1

Primary GPIB Address ........ →0          ↑  Select the primary GPIB address by
Secondary GPIB Address ...... NONE           using the left and right arrow keys.
Timeout setting ............. 10sec
                                             This address is used to compute the
Terminate Read on EOS ....... Yes            talk and listen addresses which
Set EOI with EOS on Writes .. Yes            identify the board or device on the
Type of compare on EOS ...... 7-Bit          GPIB. Valid primary addresses range
EOS byte .................... 0Ah            from 0 to 30 (00H to 1EH).
Send EOI at end of Write .... Yes
                                             * Adding 32 to the primary address
System Controller ........... Yes              forms the Listen Address (LA).
Assert REN when SC .......... No             * Adding 64 to the primary address
Enable Auto Serial Polling .. No               forms the Talk Address (TA).
Enable CIC Protocol ......... No
Bus Timing .................. 500nsec       EXAMPLE: Selecting a primary address
Parallel Poll Duration ...... Default        of 10 yields the following:

Use this GPIB board ......... Yes              10 + 32 = 42   (Listen address)
Board Type .................. PCII        ↓    10 + 64 = 74   (Talk address)
Base I/O Address ............ 02B8h
F1: Help  F6: Reset Value  F9/Esc: Return to Map  Ctl PgUp/PgDn: Next/Prev Board
```

```
National Instruments          DEV12 Configuration       GPIB-PC2/2A Ver 2.1

Primary GPIB Address ........ →12         ↑  Select the primary GPIB address by
Secondary GPIB Address ...... NONE           using the left and right arrow keys.
Timeout setting ............. 10sec
Serial Poll Timeout ......... 1sec           This address is used to compute the
                                             talk and listen addresses which
Terminate Read on EOS ....... Yes            identify the board or device on the
Set EOI with EOS on Writes .. Yes            GPIB. Valid primary addresses range
Type of compare on EOS ...... 7-Bit          from 0 to 30 (00H to 1EH).
EOS byte .................... 0Ah
Send EOI at end of Write .... Yes            * Adding 32 to the primary address
                                               forms the Listen Address (LA).
Enable Repeat Addressing .... Yes            * Adding 64 to the primary address
                                               forms the Talk Address (TA).

                                             EXAMPLE: Selecting a primary address
                                             of 10 yields the following:

                                          ↓    10 + 32 = 42   (Listen address)
                                               10 + 64 = 74   (Talk address)

F1: Help  F6: Reset Value  F9/Esc: Return to Map  Ctl PgUp/PgDn: Next/Prev Board
```

Figure 6-1. Typical National Instruments GPIB Configuration from IBCONF.EXE

6.2 SERIAL INTERFACE OVERVIEW

The serial interface used in the Model CYD218 is commonly referred to as an RS-232C interface. RS-232C is a standard of the Electronics Industries Association (EIA) that describes one of the most common interfaces between computers and electronic equipment. The RS-232C standard is quite flexible and allows many different configurations. However, any two devices claiming RS-232C compatibility cannot necessarily be plugged together without interface setup. The remainder of this paragraph briefly describes the key features of a serial interface that are supported by the instrument. A customer supplied computer with similarly configured interface port is required to enable communication.

6.2.1 Physical Connection

The Model CYD218 has a 9 pin D-Subminiature plug on the rear panel for serial communication. The original RS-232C standard specifies 25 pins but both 9- and 25-pin connectors are commonly used in the computer industry. Many third party cables exist for connecting the instrument to computers with either 9- or 25-pin connectors. Paragraph 6.5 gives the most common pin assignments for 9- and 25-pin connectors. Please note that not all pins or functions are supported by the Model CYD218.

The instrument serial connector is the plug half of a mating pair and must be matched with a socket on the cable. If a cable has the correct wiring configuration but also has a plug end, a "gender changer" can be used to mate two plug ends together.

The letters DTE near the interface connector stand for Data Terminal Equipment and indicate the pin connection of the directional pins such as transmit data (TD) and receive data (RD). Equipment with Data Communications Equipment (DCE) wiring can be connected to the instrument with a straight through cable. As an example, pin 3 of the DTE connector holds the transmit line and pin 3 of the DCE connector holds the receive line so the functions complement.

It is likely both pieces of equipment are wired in the DTE configuration. In this case pin 3 on one DTE connector (used for transmit) must be wired to pin 2 on the other (used for receive). Cables that swap the complementing lines are called null modem cables and must be used between two DTE wired devices. Null modem adapters are also available for use with straight through cables. Paragraph 7.8 illustrates suggested cables that can be used between the instrument and common computers.

The instrument uses drivers to generate the transmission voltage levels required by the RS-232C standard. These voltages are considered safe under normal operating conditions because of their relatively low voltage and current limits. The drivers are designed to work with cables up to 50 feet in length.

To maintain Electromagnetic Compatibility (EMC), add the clamp-on ferrite filter (P/N 9009-020) included with the connector kit to the Serial Interface cable near the instrument rear panel when that interface is used.

6.2.2 Hardware Support

The Model CYD218 interface hardware supports the following features. Asynchronous timing is used for the individual bit data within a character. This timing requires start and stop bits as part of each character so the transmitter and receiver can resynchronized between each character. Half duplex transmission allows the instrument to be either a transmitter or a receiver of data but not at the same time. Communication speeds of 300, 1200, or 9600 baud are supported. The Baud rate is the only interface parameter that can be changed by the user.

Hardware handshaking is not supported by the instrument. Handshaking is often used to guarantee that data message strings do not collide and that no data is transmitted before the receiver is ready. In this instrument appropriate software timing substitutes for hardware handshaking. User programs must take full responsibility for flow control and timing as described in Paragraph 6.2.5.

6.2.3 Character Format

A character is the smallest piece of information that can be transmitted by the interface. Each character is 10 bits long and contains data bits, bits for character timing and an error detection bit. The instrument uses 7 bits for data in the ASCII format. One start bit and one stop bit are necessary to synchronize consecutive characters. Parity is a method of error detection. One parity bit configured for odd parity is included in each character.

ASCII letter and number characters are used most often as character data. Punctuation characters are used as delimiters to separate different commands or pieces of data. Two special ASCII characters, carriage return (CR 0DH) and line feed (LF 0AH), are used to indicate the end of a message string.

Table 6-2. Serial Interface Specifications

Connector Type:	DE-9 D-Style Connector
Connector Wiring:	DTE
Voltage Levels:	EIA RS-232C Specified
Transmission Distance:	50 feet maximum
Timing Format:	Asynchronous
Transmission Mode:	Half Duplex
Baud Rate:	300, 1200, 9600
Handshake:	Software timing
Character Bits:	1 Start, 7 Data, 1 Parity, 1 Stop
Parity:	Odd
Terminators:	CR(0DH) LF(0AH)
Command Rate:	20 commands per second maximum

6.2.4 Message Strings

A message string is a group of characters assembled to perform an interface function. There are three types of message strings commands, queries and responses. The computer issues command and query strings through user programs, the instrument issues responses. Two or more command strings can be chained together in one communication but they must be separated by a semi-colon (;). Only one query is permitted per communication but it can be chained to the end of a command. The total communication string must not exceed 64 characters in length.

A command string is issued by the computer and instructs the instrument to perform a function or change a parameter setting. The format is:

<command mnemonic><space><parameter data><terminators>.

Command mnemonics and parameter data necessary for each one is described in Paragraph 4.3. Terminators must be sent with every message string.

A query string is issued by the computer and instructs the instrument to send a response. The query format is:

<query mnemonic><?><space><parameter data><terminators>.

Query mnemonics are often the same as commands with the addition of a question mark. Parameter data is often unnecessary when sending queries. Query mnemonics and parameter data if necessary is described in Paragraph 6.3. Terminators must be sent with every message string. The computer should expect a response very soon after a query is sent.

A response string is the instruments response or answer to a query string. The instrument will respond only to the last query it receives. The response can be a reading value, status report or the present value of a parameter. Response data formats are listed along with the associated queries in Paragraph 6.3. The response is sent as soon as possible after the instrument receives the query. Typically it takes 10 ms for the instrument to begin the response. Some responses take longer.

6.2.5 Message Flow Control

It is important to remember that the user program is in charge of the serial communication at all times. The instrument can not initiate communication, determine which device should be transmitting at a given time or guarantee timing between messages. All of this is the responsibility of the user program.

When issuing commands only the user program should:

- Properly format and transmit the command including terminators as one string.
- Guarantee that no other communication is started for 50 ms after the last character is transmitted.
- Not initiate communication more than 20 times per second.

When issuing queries or queries and commands together the user program should:

- Properly format and transmit the query including terminators as one string.
- Prepare to receive a response immediately.
- Receive the entire response from the instrument including the terminators.
- Guarantee that no other communication is started during the response or for 50 ms after it completes.
- Not initiate communication more than 20 times per second.

Failure to follow these simple rules will result in inability to establish communication with the instrument or intermittent failures in communication.

6.2.6 Changing Baud Rate

To use the Serial Interface, you must first set the Baud rate. Press **Interface** key to display the following screen.

```
Serial I/O Setup
Baud
Select with ▲▼
Baud 1200
```

Press the ▲ or ▼ keys to cycle through the choices of 300, 1200, or 9600 Baud. Press **Enter** to accept the new number.

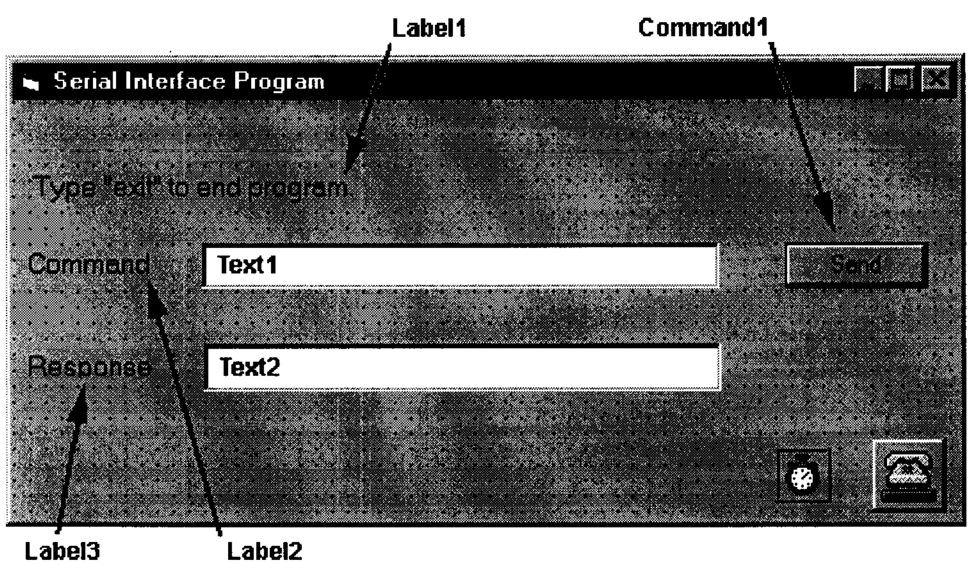
6.2.7 Serial Interface Basic Programs

Two BASIC programs are included to illustrate the serial communication functions of the instrument. The first program was written in Visual Basic. Refer to Paragraph 6.2.7.1 for instructions on how to setup the program. The Visual Basic code is provided in Table 6-4. The second program was written in Quick Basic. Refer to Paragraph 6.2.7.2 for instructions on how to setup the program. The Quick Basic code is provided in Table 6-5. Finally, a description of operation common to both programs is provided in Paragraph 6.2.7.3. While the hardware and software required to produce and implement these programs not included with the instrument, the concepts illustrated apply to almost any application where these tools are available.

6.2.7.1 Visual Basic Serial Interface Program Setup

The serial interface program (Table 6-3) works with Visual Basic 6.0 (VB6) on an IBM PC (or compatible) with a Pentium-class processor. A Pentium 90 or higher is recommended, running Windows 95 or better, with a serial interface. It uses the COM1 communications port at 9600 Baud. Use the following procedure to develop the Serial Interface Program in Visual Basic.

1. Start VB6.
2. Choose Standard EXE and select Open.
3. Resize form window to desired size.
4. On the Project Menu, click Components to bring up a list of additional controls available in VB6.
5. Scroll through the controls and select Microsoft Comm Control 6.0. Select OK. In the toolbar at the left of the screen, the Comm Control will have appeared as a telephone icon.
6. Select the Comm control and add it to the form.
7. Add controls to form:
   a. Add three Label controls to the form.
   b. Add two TextBox controls to the form.
   c. Add one CommandButton control to the form.
   d. Add one Timer control to the form.
8. On the View Menu, select Properties Window.
9. In the Properties window, use the dropdown list to select between the different controls of the current project.

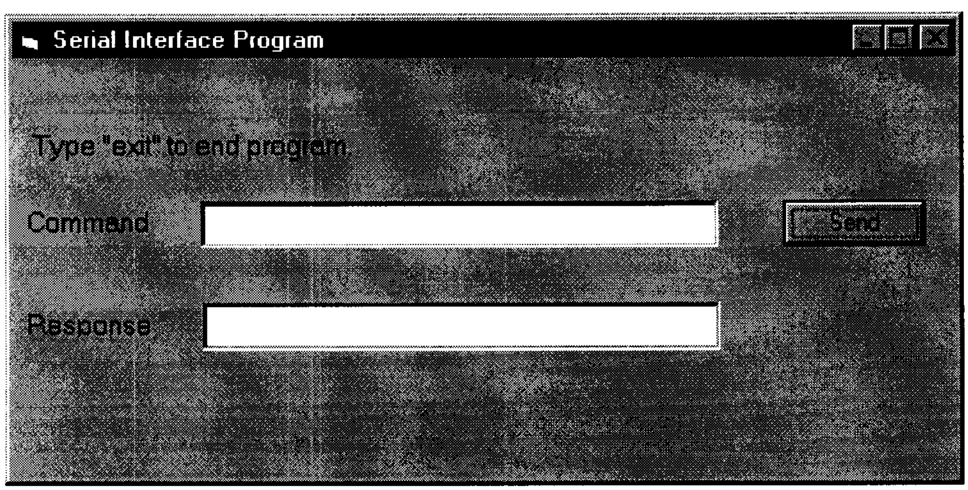


10. Set the properties of the controls as defined in Table 6-3.
11. Save the program.

Table 6-3. Serial Interface Program Control Properties

Current Name	Property	New Value
Label1	Name Caption	lblExitProgram Type “exit” to end program.
Label2	Name Caption	lblCommand Command
Label3	Name Caption	lblResponse Response
Text1	Name Text	txtCommand <blank>
Text2	Name Text	txtResponse <blank>
Command1	Name Caption Default	cmdSend Send True
Form1	Name Caption	frmSerial Serial Interface Program
Timer1	Enabled Interval	False 10

12. Add code (provided in Table 6-4).
    a. In the Code Editor window, under the Object dropdown list, select (General). Add the statement: Public gSend as Boolean
    b. Double Click on cmdSend. Add code segment under Private Sub cmdSend_Click( ) as shown in Table 6-4.
    c. In the Code Editor window, under the Object dropdown list, select Form. Make sure the Procedure dropdown list is set at Load. The Code window should have written the segment of code: Private Sub Form_Load( ). Add the code to this subroutine as shown in Table 6-4.
    d. Double Click on the Timer control. Add code segment under Private Sub Timer1_Timer() as shown in Table 6-4.
    e. Make adjustments to code if different Com port settings are being used.
13. Save the program.
14. Run the program. The program should resemble the following.



15. Type in a command or query in the Command box as described in Paragraph 6.2.7.3.
16. Press Enter or select the Send button with the mouse to send command.
17. Type Exit and press Enter to quit.

Table 6-4. Visual Basic Serial Interface Program

```
Public gSend As Boolean                                  'Global used for Send button state

Private Sub cmdSend_Click()                              'Routine to handle Send button press
    gSend = True                                         'Set Flag to True
End Sub

Private Sub Form_Load()                                  'Main code section
    Dim strReturn As String                              'Used to return response
    Dim strHold As String                                'Temporary character space
    Dim Term As String                                   'Terminators
    Dim ZeroCount As Integer                             'Counter used for Timing out
    Dim strCommand As String                             'Data string sent to instrument

    frmSerial.Show                                       'Show main window
    Term = Chr(13) & Chr(10)                             'Terminators are <CR><LF>
    ZeroCount = 0                                        'Initialize counter
    strReturn = ""                                       'Clear return string
    strHold = ""                                         'Clear holding string
    If frmSerial.MSComm1.PortOpen = True Then            'Close serial port to change settings
        frmSerial.MSComm1.PortOpen = False
    End If
    frmSerial.MSComm1.CommPort = 1                       'Example of Comm 1
    frmSerial.MSComm1.Settings = "9600,o,7,1"            'Example of 9600 Baud,Parity,Data,Stop
    frmSerial.MSComm1.InputLen = 1                       'Read one character at a time
    frmSerial.MSComm1.PortOpen = True                    'Open port

  Do
    Do                                                   'Wait loop
    DoEvents                                             'Give up processor to other events
    Loop Until gSend = True                              'Loop until Send button pressed
    gSend = False                                        'Set Flag as false

    strCommand = frmSerial.txtCommand.Text               'Get Command
    strReturn = ""                                       'Clear response display

    strCommand = UCase(strCommand)                       'Set all characters to upper case
    If strCommand = "EXIT" Then                          'Get out on EXIT
        End
    End If

    frmSerial.MSComm1.Output = strCommand & Term         'Send command to instrument
    If InStr(strCommand, "?") <> 0 Then                  'Check to see if query
        While (ZeroCount < 20) And (strHold <> Chr$(10)) 'Wait for response
            If frmSerial.MSComm1.InBufferCount = 0 Then  'Add 1 to timeout if no character
                frmSerial.Timer1.Enabled = True
                Do
                DoEvents                                 'Wait for 10 millisecond timer
                Loop Until frmSerial.Timer1.Enabled = False
                ZeroCount = ZeroCount + 1                'Timeout at 2 seconds
            Else
                ZeroCount = 0                            'Reset timeout for each character
                strHold = frmSerial.MSComm1.Input        'Read in one character
                strReturn = strReturn + strHold          'Add next character to string
            End If
        Wend                                             'Get characters until terminators

        If strReturn <> "" Then                          'Check if string empty
            strReturn = Mid(strReturn, 1, InStr(strReturn, Term) - 1)  'Strip terminators
        Else
            strReturn = "No Response"                    'Send No Response
        End If
        frmSerial.txtResponse.Text = strReturn           'Put response in textbox on main form
        strHold = ""                                     'Reset holding string
        ZeroCount = 0                                    'Reset timeout counter
    End If
  Loop
End Sub

Private Sub Timer1_Timer()                               'Routine to handle Timer interrupt
    frmSerial.Timer1.Enabled = False                     'Turn off timer
End Sub
```

6.2.7.2 Quick Basic Serial Interface Program Setup

The serial interface program (Table 6-5) works with QuickBasic 4.0/4.5 or Qbasic on an IBM PC (or compatible) running DOS or in a DOS window with a serial interface. It uses the COM1 communication port at 9600 Baud. Use the following procedure to develop the Serial Interface Program in Quick Basic.

1. Start the Basic program.
2. Enter the program exactly as presented in Table 6-5.
3. Adjust the Com port and Baud rate in the program as necessary.
4. Lengthen the "TIMEOUT" count if necessary.
5. Save the program.
6. Run the program.
7. Type a command query as described in Paragraph 6.2.7.3.
8. Type "EXIT" to quit the program.

Table 6-5. Quick Basic Serial Interface Program

```
       CLS                                                   'Clear screen
       PRINT " SERIAL COMMUNICATION PROGRAM"
       PRINT
       TIMEOUT = 2000                                        'Read timeout (may need more)
       BAUD$ = "9600"
       TERM$ = CHR$(13) + CHR$(10)                           'Terminators are <CR><LF>
       OPEN "COM1:" + BAUD$ + ",O,7,1,RS" FOR RANDOM AS #1 LEN = 256

LOOP1: LINE INPUT "ENTER COMMAND (or EXIT):"; CMD$          'Get command from keyboard
       CMD$ = UCASE$(CMD$)                                   'Change input to upper case
          IF CMD$ = "EXIT" THEN CLOSE #1: END                'Get out on Exit
       CMD$ = CMD$ + TERM$
       PRINT #1, CMD$;                                       'Send command to instrument

       IF INSTR(CMD$, "?") <> 0 THEN                         'Test for query
          RS$ = ""                                           'If query, read response
          N = 0                                              'Clr return string and count

          WHILE (N < TIMEOUT) AND (INSTR(RS$, TERM$) = 0)    'Wait for response
             IN$ = INPUT$(LOC(1), #1)                        'Get one character at a time
             IF IN$ = "" THEN N = N + 1 ELSE N = 0           'Add 1 to timeout if no chr
             RS$ = RS$ + IN$                                 'Add next chr to string
          WEND                                               'Get chrs until terminators

          IF RS$ <> "" THEN                                  'See if return string is empty
             RS$ = MID$(RS$, 1, (INSTR(RS$, TERM$) - 1))     'Strip off terminators
             PRINT "RESPONSE:"; RS$                          'Print response to query
          ELSE
             PRINT "NO RESPONSE"                             'No response to query
          END IF
       END IF                                                'Get next command
       GOTO LOOP1
```

6.2.7.3 Program Operation

Once either program is running, try the following commands and observe the response of the instrument. Input from the user is shown in **bold** and terminators are added by the program. The word [term] indicates the required terminators included with the response.

`ENTER COMMAND?` **`KRDG? 1`**	Query Kelvin Reading for Input 1. Monitor will return a temperature reading in Kelvin.
`RESPONSE: +77.350[term]`	
`ENTER COMMAND?` **`AOUT? 1`**	Query Analog Output for data output 1. Monitor will return output reading in percent.
`RESPONSE: +10.122[term]`	
`ENTER COMMAND?` **`DISPFLD 3,1,3`**	Configures display field 3 to display input 1 in sensor units.
`ENTER COMMAND?` **`FILTER? 5`**	Query filter parameters for input 5. Monitor returns filter settings.
`RESPONSE: 1,08,08[term]`	
`ENTER COMMAND?` **`INCRV 7,2;INCRV? 7`**	Combination command. Selects curve 2 for input 7 and then requests input 7 curve number.
`RESPONSE: 02[term]`	

The following are additional notes on using either Serial Interface program.

- If you enter a correctly spelled query without a "**?**," nothing will be returned. Incorrectly spelled commands and queries are ignored. Commands and queries and should have a space separating the command and associated parameters.
- Leading zeros and zeros following a decimal point are not needed in a command string, but they will be sent in response to a query. A leading "**+**" is not required but a leading "**–**" *is* required.

6.2.8 Trouble Shooting

New Installation

1. Check instrument baud rate
2. Make sure transmit (TD) signal line from the instrument is routed to receive (RD) on the computer and vice versa. (Use a null modem adapter if not).
3. Always send terminators
4. Send entire message string at one time including terminators. (Many terminal emulation programs do not.)
5. Send only one simple command at a time until communication is established.
6. Be sure to spell commands correctly and use proper syntax.

Old Installation No Longer Working

1. Power instrument off then on again to see if it is a soft failure.
2. Power computer off then on again to see if communication port is locked up.
3. Verify that baud rate has not been changed on the instrument during a memory reset.
4. Check all cable connections.

Intermittent Lockups

1. Check cable connections and length.
2. Increase delay between all commands to 100 ms to make sure instrument is not being over loaded.

6.3 IEEE-488/SERIAL INTERFACE COMMANDS

Parameter conventions in the command list are:

<??? enable>	A parameter with **enable** in the name uses these values: **0** (disabled) or **1** (enable).
<??? status>	A parameter with **status** in the name uses these values: **0** (disabled/off) or **1** (enabled/on).
<??? value>	A parameter with **value** in the name is specified in floating point format.
<bit weighting>	A number between 0 and 255 derived from the sum of all the weighted bit values.
<input>	Indicates which sensor input to use. Valid values: **1 – 8**.
<off/on>	Indicates whether an item is turned off or turned on. **0** is off and **1** is on.
<output>	Indicates which analog output to use. Valid values: **1 – 2**.
[term]	Used when examples are given and indicates where terminating characters should be placed by the user or where they appear on a returning character string from the Model CYD218.

Table 6-5. Model CYD218 Interface Commands

Command	Function	Page
*CLS	Clear Interface	17
*ESE	Set Std. Event Status Enable	17
*ESE?	Query Std. Event Status Enable	17
*ESR?	Query Std. Event Status Register	17
*IDN?	Query Identification	17
*OPC	Set Operation Complete	17
*OPC?	Query Operation Complete	18
*RST	Reset Instrument	18
*SRE	Set Service Request Enable	18
*SRE?	Query Service Request Enable	18
*STB?	Query Status Byte	18
*TST?	Query Self-Test	18
*WAI	Wait-To-Continue	18
ALARM	Set Alarm	19
ALARM?	Query Alarm	19
ALARMST?	Query Alarm Status	19
ALMB	Set Audible Alarm	19
ALMB?	Query Audible Alarm Parameters	19
ALMRST	Reset Alarms	19
ANALOG	Set Analog Outputs	20
ANALOG?	Query Analog Outputs	20
AOUT?	Query Analog Output Data	20
BAUD	Set Serial Interface Baud Rate	20
BAUD?	Query Serial Interface Baud Rate	20
CRDG?	Query Celsius Reading	21
CRVDEL	Erase a Curve	21
CRVHDR	Set Curve Header	21
CRVHDR?	Query Curve Header	21
CRVPT	Set Curve Point	21
CRVPT?	Query Curve Point	22
DATETIME	Set Date and Time	22
DATETIME?	Query Date and Time	22
DFLT	Set To Factory Defaults	22
DISPFLD	Set Display Field	22
DISPFLD?	Query Display Field	22
FILTER	Set Filter	23
FILTER?	Query Filter	23
IEEE	Set IEEE Interface	23
IEEE?	Query IEEE Interface	23
INCRV	Set Input Curve	23
INCRV?	Query Input Curve	23
INPUT	Set Input Control	24
INPUT?	Query Input Control	24
INTYPE	Set Input Type	24
INTYPE?	Query Input Type	24
KEYST?	Query Keypad Status	24
KRDG?	Query Kelvin Reading	24
LINEAR	Set Linear Equation	25
LINEAR?	Query Linear Equation	25
LOCK	Set Lock-out and Code	25
LOCK?	Query Lock-out and Code	25
LOG	Turns Logging On and Off	25
LOG?	Query Logging Status	25
LOGNUM?	Query Last Log Record Stored	25
LOGREAD	Set Log Records	26
LOGREAD?	Query Log Record Parameters	26
LOGSET	Configure Logging Parameters	26
LOGSET?	Query Logging Parameters	26
LOGVIEW?	Query Logged Data Record	26
LRDG?	Query Linear Equation Input Data	27
MNMX	Set Max/Min	27
MNMX?	Query Max/Min	27
MNMXRDG?	Query Max/Min Data	27
MNMXRST	Reset Min/Max Function	27
MODE	Set Local/Remote Mode	27
MODE?	Query Local/Remote Mode	27
RDGST?	Query Reading Status	28
RELAY	Set Relay	28
RELAY?	Query Relay	28
RELAYST?	Query Relay Status	28
SCAL	Generate SoftCal™ Curve	29
SRDG?	Query Sensor Units Reading	29

IEEE-488/SERIAL INTERFACE COMMANDS (ALPHABETICAL LISTING)

∗CLS Clear Interface Command
Input: **∗CLS**
Returned: Nothing
Remarks: Clears bits in the Status Byte Register and Standard Event Status Register and terminates all pending operations. Clears the interface, but *not* the instrument. See **∗RST** command.

∗ESE Configure Status Reports in the Standard Event Status Register
Input: **∗ESE <bit weighting>**
Returned: Nothing
Remarks: Each bit is assigned a bit weighting and represents the enable/disable status of the corresponding event flag bit in the Standard Event Status Register. To enable an event flag bit, send the command **∗ESE** with the sum of the bit weighting for each desired bit. See the **∗ESR?** command for a list of event flags.
Example: To enable event flags 0, 3, 4, and 7, send **∗ESE 143[term]**. 143 is the bit weighting sum for each bit.

Bit	Bit Weighting	Event Name
0	1	OPC
3	8	DDE
4	16	EXE
7	128	PON
	143	

∗ESE? Query the Configuration of Status Reports in the Standard Event Status Register
Input: **∗ESE?**
Returned: **<ESE bit weighting>**. Format: **nnn[term]**
Remarks: The integer returned represents the sum of the bit weighting of the enable bits in the Standard Event Status Enable Register. See the **∗ESR?** command for a list of event flags.

∗ESR? Query Standard Event Status Register
Input: **∗ESR?**
Returned: **<ESR bit weighting>**. Format: **nnn[term]**
Remarks: Queries for various Model CYD218 error conditions and status. The integer returned represents the sum of the bit weighting of the event flag bits in the Standard Event Status Register.

Bit	Bit Weighting	Event Name	Bit	Bit Weighting	Event Name
0	1	OPC	4	16	EXE
2	4	QYE	5	32	CME
3	8	DDE	7	128	PON

∗IDN? Query Identification
Input: **∗IDN?**
Returned: **<manufacturer>, <model number>, <serial number>, <firmware date>**
Format: **LSCI,MODEL218S,aaaaaa,nnnnnn[term]**
Remarks: Identifies the instrument model and software level.

∗OPC Operation Complete Command
Input: **∗OPC**
Returned: Nothing
Remarks: Generates an Operation Complete event in the Standard Event Status Register upon completion of all pending selected device operations.

∗OPC? Query Operation Complete
Input: **∗OPC?**
Returned: 1. Format: **n[term]**
Remarks: Places a "1" in the controller output queue upon completion of all pending selected device operations. Send this as the last command in a command string. This is *not* the same function as the **∗OPC** command.

∗RST Reset Instrument
Input: **∗RST**
Returned: Nothing
Remarks: Sets controller parameters to power-up settings.

∗SRE Configure Status Reports in the Service Request Enable Register
Input: **∗SRE <bit weighting>**
Returned: Nothing
Remarks: Each bit has a bit weighting and represents the enable/disable status of the corresponding status flag bit in the Status Byte Register. To enable a status flag bit, send the command **∗SRE** with the sum of the bit weighting for each desired bit. See the **∗STB?** command for a list of status flags.
Example: To enable status flags 0, 3, 4, and 6, send ***SRE 89[term]**. 89 is the bit weighting sum for each bit.

Bit	Bit Weighting	Event Name
0	1	New Reading
3	8	Alarm
4	16	Error
6	64	SRQ
	89	

∗SRE? Query the Configuration of Status Reports in the Service Request Enable Register
Input: **∗SRE?**
Returned: **<SRE bit weighting>**. Format: **nnn[term]**
Remarks: The integer returned represents the sum of the bit weighting of the enabled bits in the Service Request Enable Register. See the **∗STB?** command for a list of status flags.

∗STB? Query Status Byte
Input: **∗STB?**
Returned: **<STB bit weighting>**. Format: **nnn[term]**
Remarks: Acts like a serial poll, but does not reset the register to all zeros. The integer returned represents the sum of the bit weighting of the status flag bits that are set in the Status Byte Register.

Bit	Bit Weighting	Event Name	Bit	Bit Weighting	Event Name
0	1	New Reading	4	16	Error
1	2	Unused	5	32	ESB
2	4	Overload	6	64	SRQ
3	8	Alarm	7	128	Datalog Done

∗TST? Query Self-Test
Input: **∗TST?**
Returned: **0** or **1**. Format: **n[term]**
Remarks: The Model CYD218 performs a self-test at power-up. **0** = no errors found, **1** = errors found.

∗WAI Wait-to-Continue
Input: **∗WAI**
Returned: Nothing
Remarks: This command is not supported in the Model CYD218.

ALARM Configure Input Alarm Parameters

Input: **ALARM <input>,<off/on>,<source>,<high value>,<low value>,<deadband>,<latch enable>**

Returned: Nothing.

Remarks: Configures the alarm parameters for an input.

- **<input>** Specifies which input to configure (**1-8**).
- **<off/on>** Determines whether the instrument checks the alarm for this input.
- **<source>** Specifies input data to check. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear data.
- **<high value>** Sets the value the source is checked against to activate the high alarm.
- **<low value>** Sets the value the source is checked against to activate low alarm.
- **<deadband>** Sets the value that the source must change outside of an alarm condition to deactivate an unlatched alarm.
- **<latch enable>** Specifies a latched alarm (remains active after alarm condition correction).

Example: **ALARM 3, 1, 1, 320.5, 250.0,1.0, 0[term]** - Turns on alarm checking for input **3**, activates high alarm if Kelvin reading is over 320.5, and deactivates the alarm when reading falls below 320.5 K minus the deadband or 319.5 K. Activates low alarm if Kelvin reading falls below 250.0 K, and deactivates the alarm when the reading rises above 250.0 K plus the deadband, or 251.0 K

ALARM? Query Input Alarm Parameters

Input: **ALARM? <input>**

Returned: **<off/on>, <source>, <high value>, <low value>, <deadband>, <latch enable>**
Format: **n,n,+/-nn.nnn,+/-nn.nnn,+nn.nnn,n[term]**

Remarks: Returns the alarm parameters of an input. See **ALARM** command for returned parameter descriptions. **<input>** specifies which input to query (**1-8**).

ALARMST? Query Input Alarm Status

Input: **ALARMST? <input>**

Returned: **<high status>, <low status>**. Format: **n,n[term]**

Remarks: Returns the alarm status of an input.

- **<input>** Specifies which input to query.
- **<high status>** Specifies high alarm status. **0** = Unactivated, **1** = Activated.
- **<low status>** Specifies low alarm status. **0** = Unactivated, **1** = Activated.

ALMB Configure Audible Alarm

Input: **ALMB <off/on>**

Returned: Nothing

Remarks: Enables or disables system alarm beeper. <off/on> disables/enables beeper. **1** = On, **0** = Off

---

ALMB? Query Audible Alarm Parameters

Input: **ALMB?**

Returned: **<beeper status>**. Format: **n[term]**.

Remarks: Returns system beeper parameters.

ALMRST Clear Alarm Status for All Inputs

Input: **ALMRST**

Returned: Nothing.

Remarks: Resets a latched active alarm after the alarm condition has cleared.

ANALOG Configure Analog Output Parameters

Input: **ANALOG <output>,<bipolar enable>,<mode>,<input>,<source>,<high value>,<low value>, <manual value>**

Returned: Nothing.

Remarks:

<output>	Specifies which analog output to configure (**1** or **2**).
<bipolar enable>	Specifies analog output: 0 = positive only, or 1 = bipolar.
<mode>	Specifies data the analog output monitors: **0** = off, **1** = input, **2** = manual.
<input>	Specifies which input to monitor if **<mode> = 1 (1-8)**.
<source>	Specifies input data. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear equation.
<high value>	If **<mode>** = **1**, this parameter represents the data at which the analog output reaches +100% output.
<low value>	If **<mode>** = **1**, this parameter represents the data at which the analog output reaches -100% output if bipolar, or 0% output if positive only.
<manual value>	If **<mode>** = **2**, this parameter is the output of the analog output.

Example: **ANALOG 2, 0, 1, 5, 1, 100.0, 0.0[term]** - Sets analog output **2** to monitor Input **5** Kelvin reading with 100.0 K at +100% output (+10.0 V) and 0.0 K at 0% output (0.0 V).

ANALOG? Query Analog Output Parameters

Input: **ANALOG? <output>**

Returned: **<bipolar enable>, <mode>, <input>, <source>, <high value>, <low value>, <manual value>**
Format: **n,n,n,n,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn[term]**.

Remarks: See the **ANALOG** command for parameter descriptions.

AOUT? Query Analog Output Data

Input: **AOUT? <output>**

Returned: **<analog output>**. Format: **+/-nn.nnn[term]**

Remarks: Returns the percentage of output. **<output>** specifies analog output to query.

BAUD Configure Serial Interface Baud Rate.

Input: **BAUD <bps>**

Returned: Nothing.

Remarks: Configures to serial interface baud rate. **<bps>** specifies bits per second (bps) rate. **0** = 300, **1** = 1200, **2** = 9600.

BAUD? Query Serial Interface Baud Rate.

Input: **BAUD?**

Returned: **<bps>**. Format: **n[term]**.

Remarks: Returns serial interface baud rate. See BAUD command for parameter descriptions.

CRDG? Query Celsius Reading for a single Input or All Inputs

Input: **CRDG? <input>**

Returned: **<Celsius value>**. Format: **+/-nn.nnn[term]**.
Or if all inputs are queried:
<Input 1 Celsius Value>,<Input 2 Celsius Value>,<Input 3 Celsius Value>,<Input 4 Celsius Value>,<Input 5 Celsius Value>,<Input 6 Celsius Value>,<Input 7 Celsius Value>,<Input 8 Celsius Value>. Format: **+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn**

Remarks: Returns the Celsius reading for a single input or all inputs. <input> specifies which input(s) to query. **0** = all inputs, **1-8** = individual input. **NOTE:** Use **0** (all inputs) when reading two or more inputs at the maximum update of 16 rdgs/sec.

CRVDEL Delete User Curve

Input: **CRVDEL <curve>**

Returned: Nothing.

Remarks: Deletes a user curve. **<curve>** specifies which curve to delete (**21-28**) for inputs 1-8.

Example: **CRVDEL 21[term] -** Deletes User Curve **21**. (input **1** user curve).

CRVHDR Configure Curve Header

Input: **CRVHDR <curve>, <name>, <SN>, <format>, <limit value>, <coefficient>**

Returned: Nothing.

Remarks:

<curve>	Specifies which curve to configure (**21-28**) for inputs 1-8.
<name>	Specifies curve name. Limited to 15 characters.
<SN>	Specifies curve serial number. Limited to 10 characters.
<format>	Specifies curve data format. **2** = V/K, **3** = Ohm/K, **4** = log Ohm/K
<limit value>	Specifies curve temperature limit in Kelvin.
<coefficient>	Specifies curve temperature coefficient. **1** = negative, **2** = positive.

Example: **CRVHDR 21,Custom,00011134,2,325.0,1[term] -** Configures User Curve 21, (input 1 user curve), with a name of CUSTOM, serial number 00011134, data format of volts vs Kelvin, upper temperature limit of 325K, and negative coefficient.

CRVHDR? Query Curve Header

Input: **CRVHDR? <curve>**

Returned: **<name>, <SN>, <format>, <limit value>, <coefficient>**
Format: **aaaaaaaaaaaaaaa,aaaaaaaaaa,n,nnn.nnn,n[term]**

Remarks: Returns a standard or user curve header. See **CRVHDR** command for parameter descriptions. **<curve>** specifies which curve to query. **1-5** = Standard Diode Curves, **6 -9** = Standard Platinum Curves, **21-28** = User Curves. **NOTE:** Curve Locations **10-20** not used.

CRVPT Configure Curve Data Point

Input: **CRVPT <curve>, <index>, <units value>, <temp value>**

Returned: Nothing.

Remarks: Configures a user curve data point..

<curve>	Specifies which curve to configure (**21-28**) for inputs 1-8.
<index>	Specifies the points index in the curve (**1** - **200**).
<units value>	Specifies sensor units for this point to 6 digits.
<temp value>	Specifies corresponding temperature in Kelvin for this point to 6 digits.

Example: **CRVPT 21, 2, 0.10191, 470.000[term] -** Sets User Curve 21 (input **1** user curve) second data point to 0.10191 sensor units and 470.000 K.

CRVPT? Query Curve Data Point

Input: **CRVPT? <curve>, <index>**

Returned: **<units value>, <temp value>**. Format: **+nnn.nnn,+nnn.nnn[term]**

Remarks: Returns a standard or user curve data point. See **CRVPT** command for parameter descriptions.

<curve> Specifies which curve to query. **1-5** = Standard Diode Curves, **6-9** = Standard Platinum Curves, **21-28** = User Curves. **NOTE:** Curve locations **10-20** not used.

<index> Specifies the points index in the curve (**1** - **200**).

DATETIME Configure Date and Time

Input: **DATETIME <MM>, <DD>, <YY>, <HH>, <mm>, <SS>**.

Returned: Nothing

Remarks: Configures date and time using 24-hour format.

<MM> Specifies month. Valid entries are: **1** - **12**.
<DD> Specifies day. Valid entries are **1** - **31**.
<YY> Specifies year. Valid entries are: **00** - **99**.
<HH> Specifies hour. Valid entries are: **0** - **23**.
<mm> Specifies minutes. Valid entries are: **0** - **59**.
<SS> Specifies seconds. Valid entries are: **0** - **59**.

Example: **DATETIME 2, 3, 99, 15, 30, 0[term]** - Sets date to February 3, 1999, time to 3:30pm.

DATETIME? Query Date and Time

Input: **DATETIME?**

Returned: **<MM>, <DD>, <YY>, <HH>, <mm>, <SS>**.
Format: **nn,nn,nn,nn,nn,nn,[term]**

Remarks: Returns date and time. See the **DATETIME** command for parameter descriptions.

DFLT Set to Factory Defaults

Input: **DFLT 99**

Returned: Nothing.

Remarks: Sets all configuration values to factory defaults and resets the instrument. The **99** is required to prevent accidentally setting the unit to defaults. Does not clear user curves or instrument calibration.

DISPFLD Configure Display Parameters

Input: **DSPFLD <location>, <input>, <source>**

Returned: Nothing.

Remarks: Configures the display parameters.

<location> Specifies display location to configure (**1** - **8**).
<input> Specifies input to display in the display location (**0** - **8**). (0=none).
< source> Specifies input data to display. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear data, **5** = minimum data, **6** = maximum data.

Example: **DSPFLD 2, 4, 1[term]** - Displays Kelvin reading for Input **4** in display location **2.**

DISPFLD? Query Displayed Field

Input: **DISPFLD? <location>**

Returned: **<input>, <source>**. Format: **n,n,n[term]**

Remarks: Returns the parameters for a displayed field. See **DISPFLD** command for returned parameter descriptions. **<location>** specifies display location to query (**1** - **8**).

FILTER Configure Input Filter Parameters

Input: **FILTER <input>, <off/on >, <points>, <window>**

Returned: Nothing.

Remarks:
<input> Specifies input to configure (**1-8**).
<off/on> Specifies whether the filter function is off or on. **0** = Off, **1** = On.
<points> Specifies how many data points the filtering function uses (**2-64**).
<window> Specifies what percent of full scale reading limits the filtering function (**1-10**). Reading changes greater than this percentage reset the filter.

Example: **FILTER 1, 1, 10, 2[term]** - Filter input 1 data through 10 readings with 2% of full scale window.

FILTER? Query Input Filter Parameters

Input: **FILTER? <input>**

Returned: **<off/on >, <points>, <window>**. Format: **n,nn,nn[term]**

Remarks: Returns input filter configuration. See **FILTER** command for returned parameter descriptions. **<input>** specifies which input to query (**1-8**).

IEEE Configure IEEE-488 Interface Parameters

Input: **IEEE[<terminator>, <EOI enable>, <address>**

Returned: Nothing.

Remarks: Configures parameters of the IEEE interface.
<terminator> Specifies the terminator. **0** = <CR><LF>, **1** = <LF><CR>, **2** = <LF>, **3** = no terminator.
<EOI enable> Disables/enables the EOI mode. **0** = Enabled, **1** = Disabled.
<address> Specifies the IEEE address.

Example: **IEEE 1, 0, 4[term]** - After receipt of the current terminator, the instrument responds to address 4, uses <CR><LF> as the new terminator and uses EOI mode.

IEEE? Query IEEE-488 Interface Parameters

Input: **IEEE?**

Returned: **<terminator>, <EOI enable>, <address>**. Format: **n,n,nn[term]**

Remarks: Returns IEEE interface parameters. See IEEE command for returned parameter descriptions.

INCRV Configure Input Curve Number

Input: **INCRV <input>, <curve number>**

Returned: Nothing

Remarks: Specifies the curve an input uses for temperature conversion.
<input> Specifies which input to configure (**1-8**).
<curve number> Specifies which curve the input uses. **0** = none, **1-5** = Standard Diode Curves, **6-9** = Standard Platinum Curves, **21-28** = User curves. Note: Curve locations **10-20** not used.

Example: **INCRV 5,6[term]** - Input **5** standard curve 6 (PT-100).

INCRV? Query Input Curve Number

Input: **INCRV? <input>**

Returned: **<curve number>**. Format: **nn[term]**

Remarks: Returns the input curve number. See the **INCRV** command for parameter descriptions.
<input> Specifies which input to query (**1-8**).
<curve number> Specifies which curve the input uses. **0** = none, **1** - **5** = Standard Diode Curves, **6-9** = Standard Platinum Curves, **21-28** = User Curves. Note: Curve locations **10-20** not used.

INPUT Configure Input Control Parameter
Input: **INPUT <input>, <off/on>**
Returned: Nothing.
Remarks: Turns selected input on or off.
<input> Specifies which input to configure(**1-8**).
<off/on> Disables/Enables input. **0** = Off, **1** = On.
Example: **INPUT 4,0** - Input **4** is turned off and not scanned.

INPUT? Query Input Control Parameter
Input: **INPUT? <input>**
Returned: **<off/on>**. Format: **n[term]**
Remarks: Returns selected input status. **<input>** specifies which input to query (**1-8**).

INTYPE Configure Input Type Parameters
Input: **INTYPE <input group>, <sensor type>**
Returned: Nothing.
Remarks: Configures input type parameters for a group of inputs.
<input group> Specifies input group to configure. **A** = inputs **1-4**, **B** = inputs **5-8**.
<sensor type> Specifies input sensor type. Valid entries:

0 = 2.5V Diode	**2** = 250Ω Platinum	**4** = 5kΩ Platinum
1 = 7.5V Diode	**3** = 500Ω Platinum	**5** = Cernox

Example: **INTYPE A, 0[term]** - Sets Inputs **1-4** sensor type to silicon diode.

INTYPE? Query Input Type Parameters
Input: **INTYPE? <input group>**
Returned: **<sensor type>**. Format: **n[term]**
Remarks: Returns input type parameters.
<input group> Specifies input group to query. **A** = inputs **1-4**, **B** = inputs **5-8.**
<sensor type> Specifies input sensor type. Valid entries:

0 = 2.5V Diode	**2** = 250Ω Platinum	**4** = 5kΩ Platinum
1 = 7.5V Diode	**3** = 500Ω Platinum	**5** = Cernox

KEYST? Query Keypad Status
Input: **KEYST?**
Returned: **<keypad status>**. Format: **n[term]**
Remarks: Returns keypad status since the last **KEYST?**. **1** = key pressed, **0** = no key pressed. **KEYST?** returns **1** after initial power-up.

KRDG? Query Kelvin Reading for a Single Input or All Inputs
Input: **KRDG? <input>**
Returned: **<Kelvin value>**. Format: **+nn.nnn[term]**
Or if all inputs are queried:
<Input 1 Kelvin Value>,<Input 2 Kelvin Value>,<Input 3 Kelvin Value>,<Input 4 Kelvin Value>,<Input 5 Kelvin Value>,<Input 6 Kelvin Value>,<Input 7 Kelvin Value>,<Input 8 Kelvin Value>. Format: **+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn**
Remarks: Returns the Kelvin reading for a single input or all inputs. **<input>** specifies which input(s) to query. **0** = all inputs, **1-8** = individual input. **NOTE:** Use **0** (all inputs) when reading two or more inputs at the maximum update rate of 16 redgs/sec.

LINEAR Configure Input Linear Equation Parameters

Input: **LINEAR <input>, <varM value>, <X source>, <varB value>**
Returned: Nothing.
Remarks: Configures the linear equation for an input.

<input> Specifies input to configure (**1-8**).
<varM value> Specifies a value for m in the equation.
<X source > Specifies input data. **1** = Kelvin, **2** = Celsius, **3** = sensor units.
<varB value> Specifies a value for b in the equation.

Example: **LINEAR 6, 1.0, 2, 3.2[term]** - The linear data for Input 6 is calculated from the Celsius reading of the input using the equation: y = 1.0 * x + 3.2.

LINEAR? Query Input Linear Equation Parameters

Input: **LINEAR? <input>**
Returned: **<varM value>,<X source>,<varB value>**. Format: **+/-nn.nnn,n,+/-nn.nnn**
Remarks: Returns input linear equation configuration. See LINEAR command for returned parameter descriptions. **<input>** specifies input to query (**1-8**).

LOCK Configure Lock-out and Lock-out Code

Input: **LOCK <off/on>, <code>**
Returned: Nothing.
Remarks: Configures keypad lock-out and lock-out code.

<off/on> Disables/enables the keypad lock-out.
<code> Specifies lock-out code. **000** - **999**.

Example: **LOCK 1, 123[term]** - Enables keypad lock-out and sets the code to 123.

LOCK? Query Lock-out and Lock-out Code

Input: **LOCK?**
Returned: **<off/on>, <code>**. Format: **n,nnn[term]**
Remarks: Returns lock-out status and lock-out code. See **LOCK** command for parameter descriptions.

LOG Turns Logging On and Off

Input: **LOG <off/on>**
Returned: Nothing.
Remarks: Turns logging on and off. **<off/on>** **0** = Off, **1** = On.

LOG? Query Logging Status

Input: **LOG?**
Returned: **<off/on>**. Format: **n[term]**
Remarks: Returns logging status. See **LOG** command for parameter descriptions.

LOGNUM? Query Number of Last Data Log Record Stored.

Input: **LOGNUM?**
Returned: **<last record number>**. Format: **nnnn[term]**
Remarks: Returns number of last data log record stored.

LOGREAD Configure Log Records

Input: **LOGREAD <reading number>, <input>, <source>**

Returned: Nothing.

Remarks: Configures log records.

<reading number>	The individual reading number (**1-8**) within a log record to configure.
<input>	The input number to log (**1-8**).
<source>	Specifies data source to log. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear data.

LOGREAD? Query Log Record Parameters

Input: **LOGREAD? <reading number>**

Returned: **<input>, <source>**. Format: **n,n[term]**.

Remarks: Returns log record parameters. See LOGREAD command description of returned parameters. **<reading number>** specifies an individual reading number (**1-8**) within a log record to query.

LOGSET Configure Logging Parameters

Input: **LOGSET <mode>, <overwrite>, <start>, <period>, <readings>**

Returned: Nothing.

Remarks: Configures logging parameters.

<mode>	Specifies logging mode. **0** = Off, **1** = Log Continuous, **2** = Log event, **3** = Print Continuous, **4** = Print Event.
<overwrite>	Specifies overwrite mode. **0** = Do not overwrite data, **1** = overwrite data.
<start>	Specifies start mode. **0** = Clear, **1** = Continue.
<period>	Specifies period in seconds (**1-3600**). If mode is Print Continuous, minimum period is **10**.
<readings>	Specifies number of readings per record (**1-8**).

LOGSET? Query Logging Parameters

Input: **LOGSET?**

Returned: **<mode>, <overwrite>, <start>, <period>, <readings>**. Format: **n,n,n,nnnn,n[term]**

Remarks: Returns logging parameters. See **LOGSET** command description of returned parameters.

LOGVIEW? Query a Logged Data Record

Input: **LOGVIEW? <record number>, <reading number>**

Returned: **<date>,<time>,<reading>,<status>,<source>**
Format: **nn/nn/nn,nn:nn:nn,+/-nn.nnn,nn,n[term]**

Remarks: Returns a single reading from a logged data record.

<date>	Date reading was recorded.
<time>	Time reading was recorded.
<reading>	Reading logged.
<status>	Represents the sum of the bit weighting of the reading status flag bits.

Bit	Bit Weighting	Status Indicator
0	1	Low Alarm
1	2	High Alarm
2	4	Temperature Over or Under Range
3	8	Sensor Over or Under Range

<source>	Returns data source recorded. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear data.

LRDG? Query Linear Equation Data for a Single Input or All Inputs.

Input: **LRDG? <input>**

Returned: **<Linear value>**. Format: **+/-nn.nnn[term]**
Or if all inputs are queried:
<Input 1 Linear Value>,<Input 2 Linear Value>,<Input 3 Linear Value>,<Input 4 Linear Value>,<Input 5 Linear Value>,<Input 6 Linear Value>,<Input 7 Linear Value>,<Input 8 Linear Value>. Format: **+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn,+/-nn.nnn+/-nn.nnn,+/-nn.nnn**

Remarks: Returns the linear equation data for an input. **<input>** specifies which input to query. **0** = all inputs, **1-8** = individual input. **NOTE:** Use **0** (all inputs) when reading two or more inputs at the maximum update rate of 16 redgs/sec.

MNMX Configure Minimum and Maximum Input Function Parameters

Input: **MNMX <input>, <source>**

Returned: Nothing.

Remarks: Configures the minimum and maximum input functions.
<input> Specifies input to configure (**1-8**).
<source> Specifies input data to process through max/min. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear data.

Example: **MNMX 1, 3[term]** - Input **1** min/max function processes data from input sensor units reading.

MNMX? Query Minimum and Maximum Input Function Parameters

Input: **MNMX? <input>**

Returned: **<source>**. Format: **n[term]**

Remarks: Returns an input min/max configuration.
<input> Specifies input to query (**1-8**).
<source> Specifies input data to process through max/min. **1** = Kelvin, **2** = Celsius, **3** = sensor units, **4** = linear data.

MNMXRDG? Query Min/Max Data for an Input

Input: **MNMXRDG? <input>**

Returned: **<min value>,<max value>**. Format: **+/-nn.nnn,+/-nn.nnn[term]**

Remarks: Returns the minimum and maximum input data. **<input>** specifies which input to query.

MNMXRST Resets Min/Max Function for All Inputs

Input: **MNMXRST**

Returned: Nothing.

Remarks: Resets the minimum and maximum data for all inputs.

MODE Configure Remote Interface Mode

Input: **MODE <mode>**

Returned: Nothing.

Remarks: Configures the remote interface mode. **<mode>** specifies which mode to operate. **0** = local, **1** = remote, **2** = remote with local lockout.

Example: **MODE 2[term]** - Places the Model CYD218 into remote mode with local lockout.

MODE? Query Remote Interface Mode

Input: **MODE?**

Returned: **<mode>**. Format: **n[term]**

Remarks: Returns the remote interface mode. **0** = local, **1** = remote, **2** = remote with local lockout.

RDGST? Query Input Status

Input: **RDGST? <input>**

Returned: **<reading bit weighting>**. Format: **nnn[term]**.

Remarks: The integer returned represents the sum of the bit weighting of the input status flag bits. **<input>** specifies which input to query.

Bit	Bit Weighting	Status Indicator	Bit	Bit Weighting	Status Indicator
4	16	temp under range	6	64	units under range
5	32	temp over range	7	128	units over range

RELAY Configure Relay Control Parameters

Input: **RELAY <relay number>, <mode>, <input alarm>, <alarm type>**

Returned: Nothing.

Remarks: Configures relay control.

<relay number> Specifies which relay to configure (**1**- **8**).

<mode> Specifies relay mode. **0** = Off, **1** = On, **2** = Alarms

<input alarm> Specifies which input alarm activates the relay when the relay is in alarm mode (**1**- **8**).

<alarm type> Specifies the input alarm type that activates the relay when the relay is in alarm mode. **0** = Low alarm, **1** = High Alarm, **2** = Both Alarms.

Examples: **RELAY 3, 2, 3, 0[term]** - Relay **3** activates when Input **3** low alarm activates.

RELAY? Query Relay Control Parameters

Input: **RELAY? <relay number>**

Returned: **<mode>, <input>, <alarm type>**.

Remarks: Returns relay control parameters. See the **RELAY** command for returned parameter descriptions. **<relay number>** specifies which relay to query.

RELAYST? Query Relay Status

Input: **RELAYST?**

Returned: **<relay status bit weighting>**. Format: **nnn[term]**

Remarks: The integer returned represents the sum of the bit weighting of the relay status.

Bit	Bit Weighting	Active Relay
0	1	Relay 1
1	2	Relay 2
2	4	Relay 3
3	8	Relay 4
4	16	Relay 5
5	32	Relay 6
6	64	Relay 7
7	128	Relay 8

SCAL Generate SoftCal™ Curve

Input: **SCAL <std>, <dest>, <SN>, <T1 value>, <U1 value>, <T2 value>, <U2 value>, <T3 value>, <U3 value>**

Returned: Nothing.

Remarks:

<std>	Specifies the standard curve to generate a SoftCal from (**1**,**6**,**7**).
<dest>	Specifies the user curve to store the SoftCal curve (**21** - **28**).
<SN>	Specifies the curve serial number. Limited to 10 characters.
<T1 value>	Specifies first temperature point.
<U1 value>	Specifies first sensor units point.
<T2 value>	Specifies second temperature point.
<U2 value>	Specifies second sensor units point.
<T3 value>	Specifies third temperature point.
<U3 value>	Specifies third sensor units point.

Example: **SCAL 1, 21, 4.2, 1.6260, 77.32, 1.0205, 300.0, 0.5189[term]** - Generates a three-point SoftCal curve from DT-470 and saves it in user curve **21**.

SRDG? Query Sensor Units Reading for a Single Input or all Inputs

Input: **SRDG? <input>**

Returned: **<sensor units value>**. Format: **+nn.nnn[term]**
Or if all units are queried:
<Input 1 Sensor Units Value>,<Input 2 Sensor Units Value>,<Input 3 Sensor Units Value>, <Input 4 Sensor Units Value>,<Input 5 Sensor Units Value>,<Input 6 Sensor Units Value>, <Input 7 Sensor Units Value>,<Input 8 Sensor Units Value>.
Format: **+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn,+nn.nnn**

Remarks: Returns the Sensor Units reading for a single input or all inputs. **<input>** Specifies which input(s) to query. **0** = all inputs, **1-8** = individual input. **NOTE:** Use **0** (all inputs) when reading two or more inputs at the maximum update rate of 16 rdgs/sec.

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CHAPTER 7

SERVICE

7.0 GENERAL

This chapter provides general service information for the Model CYD218 Temperature monitor including: General Maintenance Precautions in Paragraph 7.1, Electrostatic Discharge in Paragraph 7.2, Line Voltage Selection in Paragraph 7.3, Fuse Replacement in Paragraph 7.4, Sensor Input Connector and Pinout in Paragraph 7.5, Terminal Block (Model CYD218S only) in Paragraph 7.6, IEEE-488 Interface Connector in Paragraph 7.7, Serial Interface Cable and Adapters in Paragraph 7.8, Top of Enclosure Remove and Replace Procedure in Paragraph 7.9, EPROM and NOVRAM Replacement in Paragraph 7.10, and Error Messages in Paragraph 7.11.

There is no calibration procedure for the Model CYD218. There are no serviceable parts inside the Model CYD218. Contact Omega Engineering about specific problems with the Model CYD218.

7.1 GENERAL MAINTENANCE PRECAUTIONS

Below are general safety precautions unrelated to any other procedure in this publication. These are recommended precautions that personnel should understand and apply during the maintenance phase.

Keep away from live circuits. Installation personnel shall observe all safety regulations at all times. Turn off system power before making or breaking electrical connections. Regard any exposed connector, terminal board, or circuit board as a possible shock hazard. Discharge charged components only when such grounding results in no equipment damage. If a test connection to energized equipment is required, make the test equipment ground connection before probing the voltage or signal to be tested.

Do not install or service equipment alone. Do not reach into or enter any enclosure to service or adjust the equipment without another person capable of rendering aid.

If there is no power, verify the power cord is plugged into a live outlet and that both ends are securely plugged in. Next, check the fuse (see Paragraph 3.3.1.1).

Clean the Model CYD218 periodically to remove dust, grease and other contaminants. Use the procedure below:

1. Clean front and back panels and case with soft cloth dampened with mild detergent and water solution.

NOTE: Do *not* use aromatic hydrocarbons or chlorinated solvents to clean the Model CYD218. They may react with the plastic materials used in the controller or the silk screen printing on the back panel.

2. Clean surface of printed circuit boards (PCBs) with clean, dry air at low pressure.

7.2 ELECTROSTATIC DISCHARGE

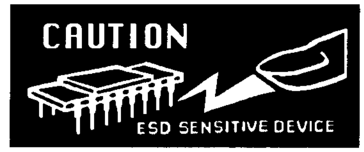
Electrostatic Discharge (ESD) may damage electronic parts, assemblies, and equipment. ESD is a transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field. The low-energy source that most commonly destroys Electrostatic Discharge Sensitive (ESDS) devices is the human body, which generates and retains static electricity. Simply walking across a carpet in low humidity may generate up to 35,000 volts of static electricity.

Current technology trends toward greater complexity, increased packaging density, and thinner dielectrics between active elements, which results in electronic devices with even more ESD sensitivity. Some electronic parts are more ESDS than others. ESD levels of only a few hundred volts may damage electronic components such as semiconductors, thick and thin film resistors, and piezoelectric crystals during testing, handling, repair, or assembly. Discharge voltages below 4000 volts cannot be seen, felt, or heard.

7.2.1 Identification of Electrostatic Discharge Sensitive Components

Below are various industry symbols used to label components as ESDS:



7.2.2 Handling Electrostatic Discharge Sensitive Components

Observe all precautions necessary to prevent damage to ESDS components before attempting installation. Bring the device and everything that contacts it to ground potential by providing a conductive surface and discharge paths. As a minimum, observe these precautions:

1. De-energize or disconnect all power and signal sources and loads used with unit.
2. Place unit on a grounded conductive work surface.
3. Ground technician through a conductive wrist strap (or other device) using 1 MΩ series resistor to protect operator.
4. Ground any tools, such as soldering equipment, that will contact unit. Contact with operator's hands provides a sufficient ground for tools that are otherwise electrically isolated.
5. Place ESDS devices and assemblies removed from a unit on a conductive work surface or in a conductive container. An operator inserting or removing a device or assembly from a container must maintain contact with a conductive portion of the container. Use only plastic bags approved for storage of ESD material.
6. Do not handle ESDS devices unnecessarily or remove from the packages until actually used or tested.

7.3 LINE VOLTAGE SELECTION

Below is the procedure to change the instrument line voltage selector. Verify the fuse value whenever line voltage is changed.

1. Identify the line input assembly on the instrument rear panel.
2. Turn the line power switch OFF.
3. Remove the instrument power cord.
4. With a small screwdriver, release the drawer holding the line voltage selector and fuse.
5. Slide out the removable plastic fuse holder from the drawer.
6. Rotate the fuse holder until the proper voltage indicator shows through the window.
7. Verify the proper fuse value.
8. Re-assemble the line input assembly in the reverse order.
9. Verify the voltage indicator in the window of the line input assembly.
10. Connect the instrument power cord.
11. Turn the line power switch ON.

7.4 FUSE REPLACEMENT

Below is the procedure to remove and replace a line fuse. Use slow blow fuses with the value shown in Table 3-1. To change line input from the factory setting, use the appropriate fuse in the connector kit shipped with the instrument.

1. Locate line input assembly on the instrument rear panel.
2. Turn power switch OFF.
3. Remove instrument power cord.
4. With a small screwdriver, release the drawer holding the line voltage selector and fuse.
5. Remove fuse and replace it with appropriate slow blow fuse.
6. Re-assemble line input assembly in reverse order.
7. Verify voltage indicator in the line input assembly window.
8. Connect instrument power cord.
9. Turn power switch ON.

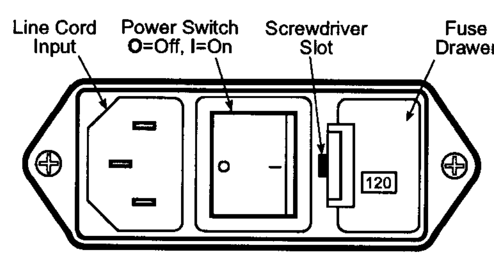
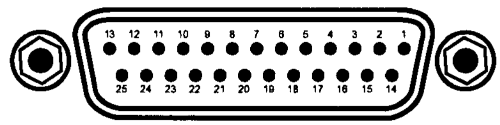


Figure 7-1. Power Fuse Access

7.5 SENSOR INPUT CONNECTOR AND PINOUT



PIN	DESC.	PIN	DESC.	PIN	DESC.	PIN	DESC.
Input Connector (Inputs 1-4)				Input Connector (Inputs 5-8)			
1	NC			1	NC		
2	S	14	S	2	S	14	S
3	1I+	15	1I-	3	5I+	15	5I-
4	1V+	16	1V-	4	5V+	16	5V-
5	S	17	S	5	S	17	S
6	2I+	18	2I-	6	6I+	18	6I-
7	2V+	19	2V-	7	6V+	19	6V-
8	S	20	S	8	S	20	S
9	3I+	21	3I-	9	7I+	21	7I-
10	3V+	22	3V-	10	7V+	22	7V-
11	S	23	S	11	S	23	S
12	4I+	24	4I-	12	8I+	24	8I-
13	4V+	25	4V-	13	8V+	25	8V-

Figure 7-2. Input Connector Pinouts (S = Shield, NC = No Connect)

7.6 TERMINAL BLOCK (Model CYD218S ONLY)

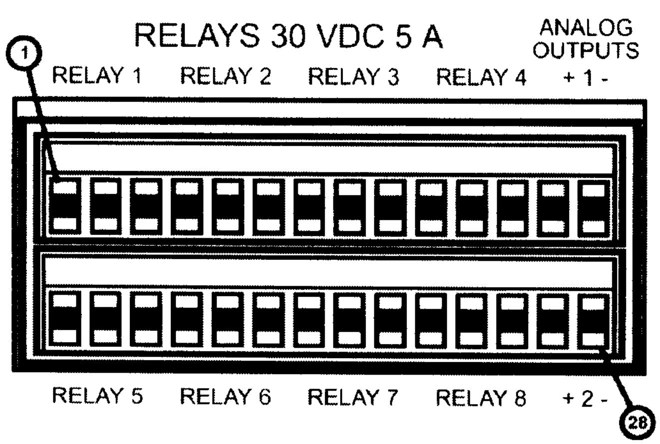


Figure 7-3. Terminal Block Connectors

Table 7-1. Terminal Block Pins

PIN	DESCRIPTION	PIN	DESCRIPTION
1	Relay 1 NC	15	Relay 5 NC
2	Relay 1 COM	16	Relay 5 COM
3	Relay 1 NO	17	Relay 5 NO
4	Relay 2 NC	18	Relay 6 NC
5	Relay 2 COM	19	Relay 6 COM
6	Relay 2 NO	20	Relay 6 NO
7	Relay 3 NC	21	Relay 7 NC
8	Relay 3 COM	22	Relay 7 COM
9	Relay 3 NO	23	Relay 7 NO
10	Relay 4 NC	24	Relay 8 NC
11	Relay 4 COM	25	Relay 8 COM
12	Relay 4 NO	26	Relay 8 NO
13	Analog 1 Signal	27	Analog 2 Signal
14	Analog 1 Gnd	28	Analog 2 Gnd

7.7 IEEE-488 INTERFACE CONNECTOR

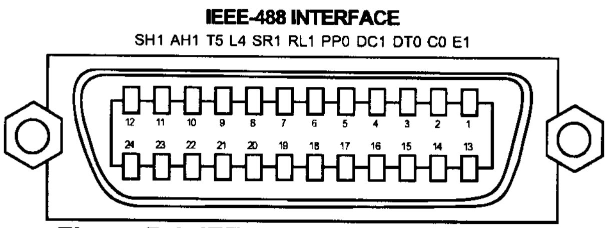
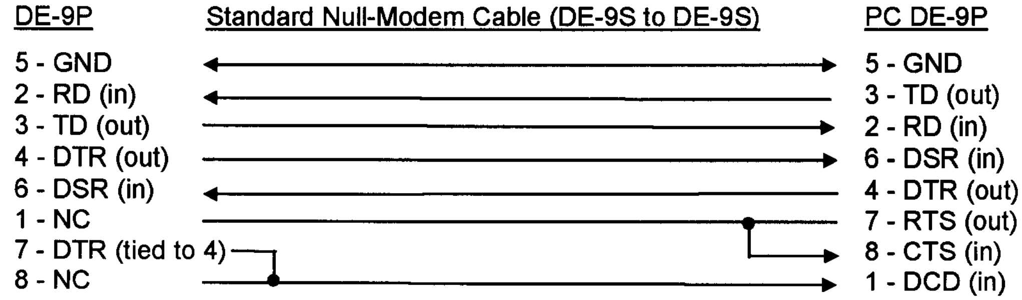


Figure 7-4. IEEE-488 Rear Panel Connector

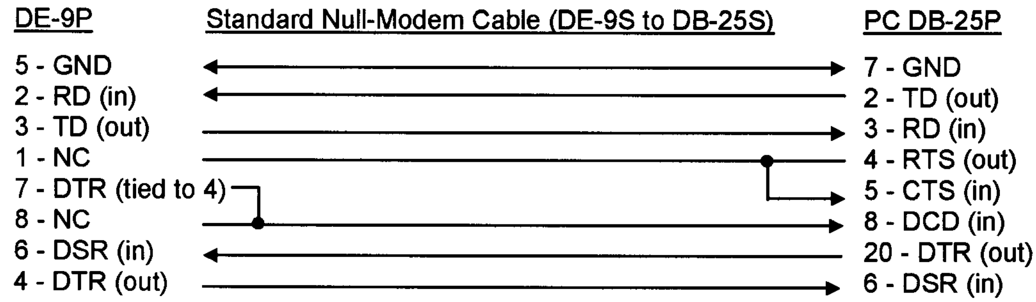
PIN	SYMBOL	DESCRIPTION
1	DIO1	Data Input/Output Line 1
2	DIO2	Data Input/Output Line 2
3	DIO3	Data Input/Output Line 3
4	DIO4	Data Input/Output Line 4
5	EOI	End Or Identify
6	DAV	Data Valid
7	NRFD	Not Ready For Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Cable Shield
13	DIO5	Data Input/Output Line 5
14	DIO6	Data Input/Output Line 6
15	DIO7	Data Input/Output Line 7
16	DIO8	Data Input/Output Line 8
17	REN	Remote Enable
18	GND 6	Ground Wire – Twisted pair with DAV
19	GND 7	Ground Wire – Twisted pair with NRFD
20	GND 8	Ground Wire – Twisted pair with NDAC
21	GND 9	Ground Wire – Twisted pair with IFC
22	GND 10	Ground Wire – Twisted pair with SRQ
23	GND11	Ground Wire – Twisted pair with ATN
24	GND	Logic Ground

7.8 SERIAL INTERFACE CABLE AND ADAPTERS

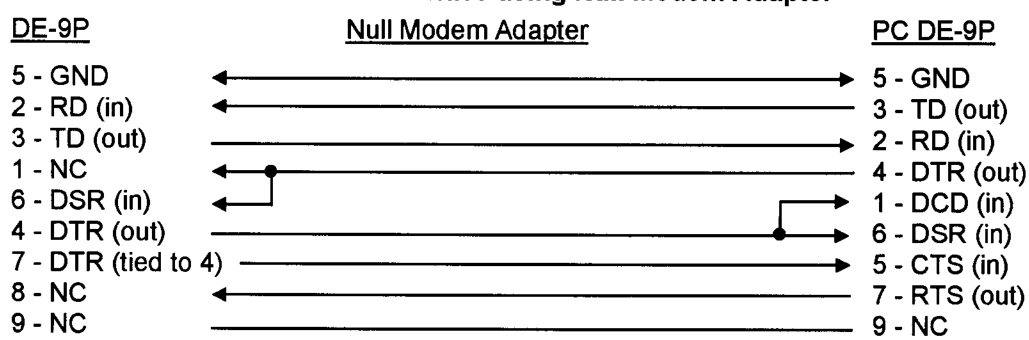
CYD218 to PC Serial Interface – PC with DE-9P



CYD218 to PC Serial Interface – PC with DB-25P

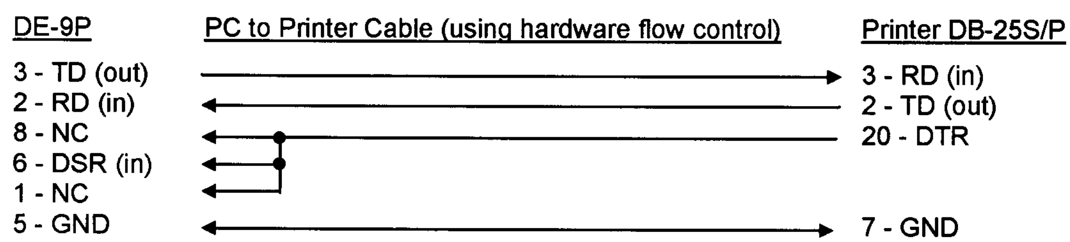


CYD218 to PC Interface using Null Modem Adapter



NOTE: Same as null modem cable design except PC CTS is provided from 218 on DTR.

CYD218 to Serial Printer (Printer with DB-25S/P)



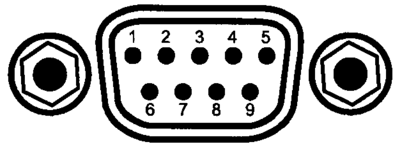


Figure 7-5 Serial Port Pinouts

Table 7-2. Typical Pin Configuration for Serial Ports on the Model CYD218, Computers, and Serial Printers

Model CYD218		**Computers and Printers**			
218 DE-9P		**DB-25P**		**DE-9P**	
Pin	**Description**	**Pin**	**Description**	**Pin**	**Description**
1	No Connection (NC)	2	TD (out)	1	DCD (in)
2	Receive Data (RD in)	3	RD (in)	2	RD (in)
3	Transmit Data (TD out)	4	RTS (out)	3	TD (out)
4	Data Terminal Ready (DTR out)	5	CTS (in)	4	DTR (out)
5	Ground (GND)	6	DSR (in)	5	GND
6	Data Set Ready (DSR in)	7	GND	6	DSR (in)
7	Data Terminal Ready (DTR out) (tied to 4)	8	DCD (in)	7	RTS (out)
8	No Connection (NC)	20	DTR (out)	8	CTS (in)
9	No Connection (NC)	22	Ring in (in)	9	Ring in (in)

7.9 TOP OF ENCLOSURE REMOVE AND REPLACE PROCEDURE

WARNING: To avoid potentially lethal shocks, turn off controller and disconnect it from AC power line before performing this procedure. Only qualified personnel should perform this procedure.

REMOVAL

1. Set power switch to Off (O) and disconnect power cord from rear of unit.
2. If attached, remove 19-inch rack mounting brackets.
3. Use 5/64 hex key to remove four screws attaching top panel to unit.
4. Use 5/64 hex key to loosen four screws attaching bottom panel to unit.
5. Carefully remove the back bezel by sliding it straight back away from the unit.
6. Slide the top panel back and remove it from the unit.

INSTALLATION

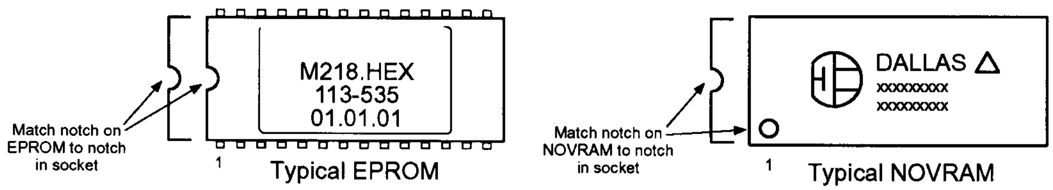
1. Slide the top panel forward in the track provided on each side of the unit.
2. Carefully replace the back bezel by sliding it straight into the unit.
3. Use 5/64 hex key to install four screws attaching top panel to unit.
4. Use 5/64 hex key to tighten four screws attaching bottom panel to unit.
5. If required, reattach 19-inch rack mounting brackets.
6. Connect power cord to rear of unit and set power switch to On (I).

7.10 EPROM AND NOVRAM REPLACEMENT

The operating software for the Model CYD218 is contained on one Erasable Programmable Read Only Memory (EPROM) Integrated Circuit (IC). The reference designator for the EPROM is U17. See Figure 7-6. The EPROM has a sticker on top labeled with "M218.HEX" and the date. The reference designator for the Non-Volatile Random Access Memory (NOVRAM) IC is U24. Use the procedure below to replace either the EPROM or the NOVRAM. **NOTE:** The factory may provide the CalCurves™ to users in U24 (NOVRAM).

CAUTION: The EPROM and NOVRAM are Electrostatic Discharge Sensitive (ESDS) devices. Wear shock-proof wrist straps (resistor limited to <5 mA) to prevent injury to service personnel and to avoid inducing an Electrostatic Discharge (ESD) into the device.

1. Follow the top of enclosure REMOVAL procedure in Paragraph 7.9.
2. Locate EPROM U17 (M218.HEX) or NOVRAM (U24) on the main circuit board. Note orientation of existing IC. See Figure 7-6.
3. Use IC puller to remove existing EPROM/NOVRAM from socket.
4. Noting orientation of new EPROM/NOVRAM, use an IC insertion tool to place new device into socket.
5. Follow the top of enclosure INSTALLATION procedure in Paragraph 7.9.



7.11 ERROR MESSAGES

Model CYD218 error messages during normal operation:

Disabled	Input is turned off.
No Curve	Input has no curve.
S. Over	Input is at/over full-scale.
S. Under	Input is at/under negative full-scale.
T. Over	Temperature conversion went off the high end of the curve.
T. Under	Temperature conversion went off the low end of the curve.
Error 1	Defective NOVRAM.
Error 2	Invalid NOVRAM - Press and hold Escape for approximately 20 seconds to initialize NOVRAM. See Paragraph 4.13.

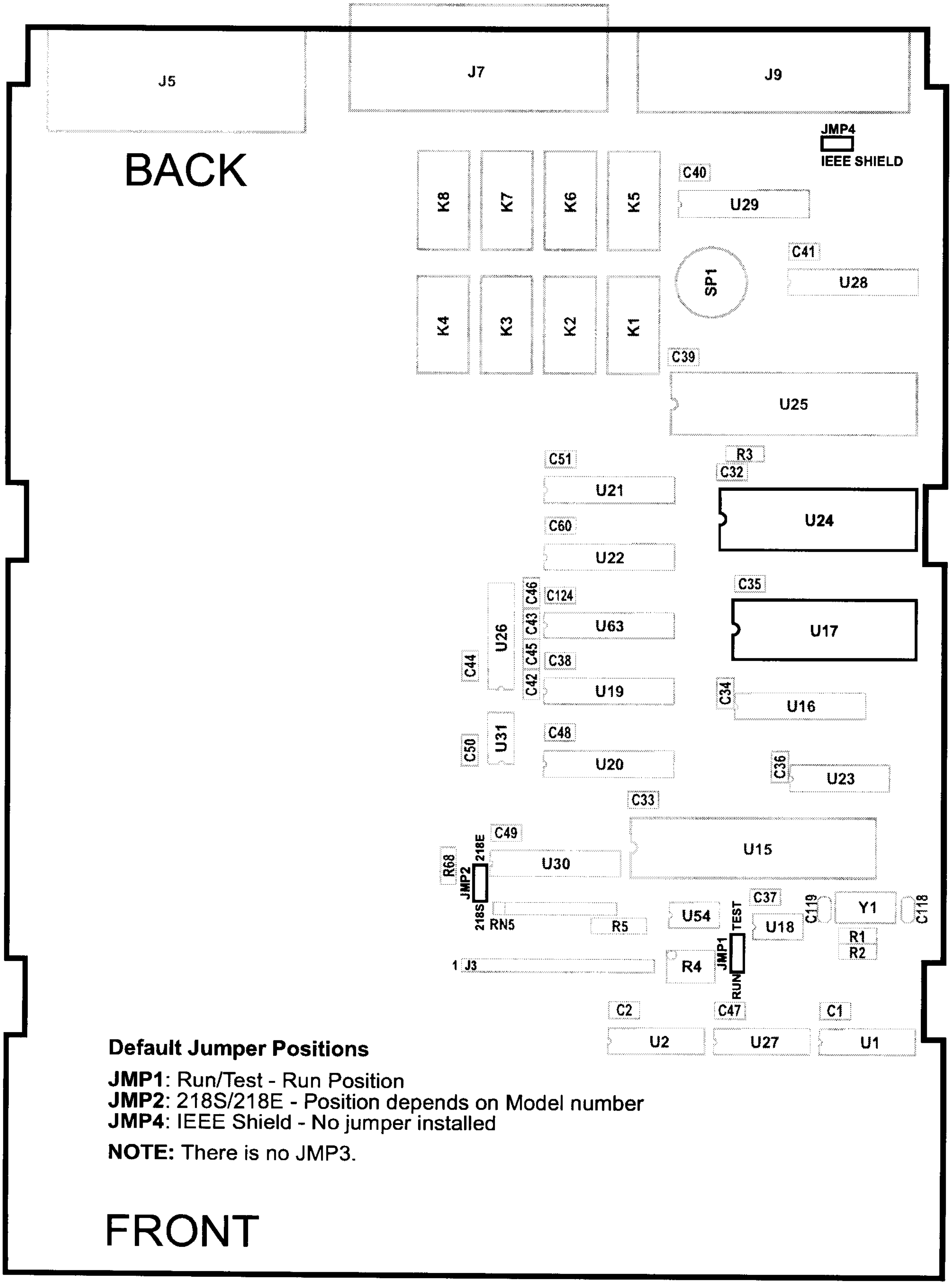


Figure 7-6. Location Of Internal Components

7.12 CALIBRATION PROCEDURE

Both groups of sensor inputs require calibration. Sensor Input groups consist of 4 separate current sources which can supply 10 µA or 1 mA of current. They are calibrated by adjusting pots on the Model CYD218 main board. The Sensor Input groups consist of 4 inputs each with multiple gain configurations to accommodate the various sensors the Model CYD218 supports. The input circuitry is not adjusted during calibration. Instead, precision voltages and resistors are attached to each input and mathematical calibration constants are calculated and programmed into the Model CYD218 to use to compensate for input offset and gain errors. Refer to Paragraph 7.12.15 for details on calibration specific interface commands.

7.12.1 Required Equipment List

1. PC with software loaded which provides serial command line communication.
2. DE-9 to DE-9 cable. Pin to pin connections on all 9 pins. Female connectors on both ends. 3 foot minimum.
3. DE-9 null modem adapter.
4. DVM with minimum 5 digits resolution.
5. Precision reference providing +2.5 ±0.00001 V and -2.5 ±0.00001 V.
6. Four 200 kΩ resistor calibrated to ±2.0Ω.
7. Four 250 Ω resistors calibrated to ±0.001Ω.
8. Four 5 kΩ resistors calibrated to ±0.025Ω.
9. Eight 100 kΩ resistor calibrated to ±0.5Ω.

7.12.2 SENSOR INPUT CALIBRATION SETUP

Allow the Model CYD218 to warm up for at least one hour with 100 kΩ resistors attached to all eight input. Configure both input groups to the 2.5 V Diode range. Connect the Model CYD218 to the PC via the serial port. Verify operational serial communication by sending the *IDN? command and receiving the proper response from the Model CYD218. During the calibration process leave four 100 kΩ resistors attached to the input group not currently being calibrated. Calibrate input group A first then repeat process for input group B.

7.12.3 Clear Calibration

Send the CALCLEAR command to return all calibration constants to their default value. Once cleared, send the CALSAVE command to save the constants in the E^2 Prom. CAUTION: Once this step is complete, the Model CYD218 sensor inputs must be completely calibrated for proper operation.

7.12.4 A/D Linearity Calibration

PURPOSE: To provide ground, positive, and negative full scale voltages to the input of the A/D to allow it to self-calibrate linearity.

CONFIG: Attach the precision +2.5 V to the 1st inputs voltage terminals, the positive side attaches to the positive terminal. Attach the precision -2.5 V to the 2nd inputs voltage terminals, the negative side attaches to the positive terminal. Connect the ground of the voltage reference to the negative input terminals of both inputs. Short the positive current source terminal to the negative current source terminal on the 1st and 2nd inputs. On the 3rd and 4th inputs short all 4 terminals together. Do not tie the 4 terminals to ground. Input group configured for 2.5 V input, all inputs of the group are enabled.

PROCESS: Via the interface send the ADCAL command specifying the input group to be calibrated. The CALSAVE command must then be issued to save the A/D calibration in the E^2 prom. Finally, the *RST command is issued to reload both A/Ds with the calibration data stored in the E^2 prom to both A/Ds.

7.12.5 Zero Calibration

PURPOSE: To determine the zero offset of the input stage and provide an offset constant back to the Model CYD218.

CONFIG: Same as Paragraph 7.12.4 above except that only the 3rd input of the group is enabled. All other inputs of the group are disabled.

PROCESS: Via the interface obtain the RAWAD reading of the 3rd input. To obtain the zero offset constant, determine the *inverse* of the value read. Write this number down. The inverse of the value read is provided back to the Model CYD218 using the ZCAL command and should be sent as the ZCAL constant to *all inputs* of the group for the 2.5 V range. The input group should then be configured for the 7.5 V range and the process repeated. Continue changing ranges and repeating the above process until ZCAL constants have been supplied for all input ranges. The ranges should be zero calibrated in the following order - 2.5V, 7.5V, 250 Ω, 500 Ω, 5 kΩ, and 7.5 kΩ. Once zero offset constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.6 2.5 Volt Input Gain Calibration

PURPOSE: To determine the input gain errors when the input is configured for the 2.5 V input and provide gain calibration constants back to the Model CYD218.

CONFIG; Same as Paragraph 7.12.4 above.

PROCESS: Via the interface obtain the RAWAD reading of the 1st input. To determine the calibration constant add the 2.5 V range zero offset constant to the value read and then divide 2.5 by that value or 2.5/(RAWAD reading + zero offset constant). For example, if the value read was 2.49940 and the zero offset constant was 0.00005 the gain calibration constant is 2.5/2.49945 = 1.00022.

This gain calibration constant is provided back to the Model CYD218 using the GCAL command. This constant is valid for all inputs of the group, therefore, GCAL must be sent 4 times assigning the constant to each input. Once gain calibration constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.7 7.5 Volt Input Gain Calibration

PURPOSE: To determine the input gain errors when the input is configured for 7.5 V input and provide gain calibration constants back to the Model CYD218.

CONFIG: Same as Paragraph 7.12.4 above except the input group is configured for 7.5 V input.

PROCESS: Via the interface obtain the RAWAD reading of the 1st input. To determine the calibration constant add the 7.5 V range zero offset constant to the value read and then divide 2.5 by that value or 2.5/(RAWAD reading + zero offset constant). For example, if the value read was 0.832248 and the zero offset constant was -0.00007 the gain calibration constant is 2.5/0.832241 = 3.00394.

This gain calibration constant is provided back to the Model CYD218 using the GCAL command. This constant is valid for all inputs of the group, therefore, GCAL must be sent 4 times assigning the constant to each input. Once gain calibration constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.8 10 μA Current Source Calibration

PURPOSE: To calibrate all 4 of the 10 μA current sources to within the specified tolerance.

TOLERANCE: 10 μA ±0.01%.

CONFIG: Attach the precision 200 kΩ resistors to each input of the group. Be sure to connect the resistors using proper 4-lead connection techniques. Input group configured to 2.5 V input, all inputs of the group are enabled. Front panel display must be set to display all inputs of the group in sensor units.

PROCESS: Adjust the four current source calibration pots on the Model CYD218 main board until each of the 4 inputs display exactly 2.0000 V.

7.12.9 250 Ω Input Gain Calibration

PURPOSE: To determine the input gain errors when the input is configured for 250 Ω input and provide gain calibration constants back to the Model CYD218.

CONFIG: Attach the precision 250 Ω resistors to each input of the group. Be sure to connect the resistors using proper 4-lead connection techniques. Input group configured for 250 Ω input, all inputs of the group are enabled.

PROCESS: Via the interface obtain the RAWAD value of the 1st input. To determine the calibration constant add the 250 Ω range zero offset constant to the value read and divide 250 by that value or 250/(RAWAD reading + zero offset constant). For example, if the value read was 2.48540 and the zero offset constant was 0.00005 the gain calibration constant is 250/2.48545 = 100.585.

This gain calibration constant is provided back to the Model CYD218 using the GCAL command for the 1st input of the group only. The above process must be repeated for the remaining 3 inputs of the group. Once gain calibration constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.10 500 Ω Input Gain Calibration

PURPOSE: To determine the input gain errors when the input is configured for 500 Ω input and provide gain calibration constants back to the Model CYD218.

CONFIG: Attach the precision 250 Ω resistors to each input of the group. Be sure to connect the resistors using proper 4-lead connection techniques. Input group configured for 500 Ω input, all inputs of the group are enabled.

PROCESS: Via the interface obtain the RAWAD value of the 1st input. To determine the calibration constant add the 500 Ω range zero offset constant to the value read and divide 250 by that value or 250/(RAWAD reading + zero offset constant). For example, if the value read was 1.24887 and the zero offset constant was 0.00009 the gain calibration constant is 250/1.24896 = 200.166.

This gain calibration constant is provided back to the Model CYD218 using the GCAL command for the 1st input of the group only. The above process must be repeated for the remaining 3 inputs of the group. Once gain calibration constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.11 7.5 kΩ Input Gain Calibration

PURPOSE: To determine the input gain errors when the input is configured for 7.5 kΩ input and provide gain calibration constants back to the Model CYD218.

CONFIG: Attach the precision 5 kΩ resistors to each input of the group. Be sure to connect the resistors using proper 4-lead connection techniques. Input group configured for 7.5 kΩ input, all inputs of the group are enabled.

PROCESS: Via the interface obtain the RAWAD value of the 1st input. To determine the calibration constant add the 7.5 kΩ range zero offset constant to the value read and divide 5000 by that value or 5000/(RAWAD reading + zero offset constant). For example, if the value read was 1.66552 and the zero offset constant was -0.00010 the gain calibration constant is 5000/1.66542 = 3002.24.

This gain calibration constant is provided back to the Model CYD218 using the GCAL command for the 1st input of the group only. The above process must be repeated for the remaining 3 inputs of the group. Once gain calibration constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.12 5 kΩ Input Gain Calibration

PURPOSE: To determine the input gain errors when the input is configured for 5 kΩ input and provide gain calibration constants back to the Model CYD218.

CONFIG: Attach the precision 5 kΩ resistors to each input of the group. Be sure to connect the resistors using proper 4-lead connection techniques. Input group configured for 5 kΩ input, all inputs of the group are enabled.

PROCESS: Via the interface obtain the RAWAD value of the 1^{st} input. To determine the calibration constant add the 5 kΩ range zero offset constant to the value read and divide 5000 by that value or 5000/(RAWAD reading + zero offset constant). For example, if the value read was 2.49870 and the zero offset constant was 0.00005 the gain calibration constant is 5000/2.49875 = 2001.00.

This gain calibration constant is provided back to the Model CYD218 using the GCAL command for the 1^{st} input of the group only. The above process must be repeated for the remaining 3 inputs of the group. Once gain calibration constants for all ranges have been determined and provided back to the Model CYD218 the CALSAVE command is issued to save the constants in the E^2 prom.

7.12.13 Calibrate Input Group B

Repeat steps in Paragraphs 7.12.4 thru .12 for input Group B (Inputs 5 – 8).

7.12.14 ANALOG OUTPUT CALIBRATION AND TEST (MODEL CYD218S ONLY)

The Model CYD218S has two analog outputs which require calibration. Zero offset and gain are adjusted for each input via pots on the Model CYD218 main board.

NOTE: Analog output calibration must be performed on both analog outputs.

7.12.14.1 Analog Output Zero Adjust

PURPOSE: To adjust the zero offset error of the analog output amplifier to 0 V.

CONFIG: The positive lead of the DVM is connected to the analog output positive terminal, the negative lead is connected to the analog output negative terminal. The DVM should be set to read DC VOLTS. Via the front panel manually set the analog output to 0 V.

TOLERANCE: ±2.5 mV

PROCESS: Adjust the offset adjust pot of the analog output being calibrated until the DVM displays 0.000 ±0.002 V.

7.12.14.2 Analog Output Gain Adjust

PURPOSE: To adjust the full scale gain error of the analog output amplifier.

CONFIG: The positive lead of the DVM is connected to the analog output positive terminal, the negative lead is connected to the analog output negative terminal. The DVM should be set to read DC VOLTS. Via the front panel manually set the analog output to +10 V.

TOLERANCE: ±2.5 mV

PROCESS: Adjust the gain adjust pot of the analog output being calibrated until the DVM displays 10.000 ±0.002 V.

7.12.14.3 Analog Output Negative Full Scale Test

PURPOSE: To check the –10 V output of the Analog Outputs

CONFIG: The positive lead of the DVM is connected to the analog output positive terminal, the negative lead is connected to the analog output negative terminal. The DVM should be set to read DC VOLTS. Via the front panel manually set the analog output to -10 V.

TOLERANCE: ±2.5 mV

PROCESS: Check the DVM reading and verify it displays –10.000 ±0.003 V.

7.12.15 CALIBRATION SPECIFIC INTERFACE COMMANDS

ADCAL Calibrates A/D Linearity

Input: ADCAL <input group>

Returned: Nothing

Remarks: Calibrates the A/D linearity of the selected input group. Before issuing command the input group must be configured as follows: A precision 2.5 V attached to input 1, a precision -2.5 V attached to input 2, and a precision ground at input 3.

<input group> Specifies which group of inputs to calibrate. Valid entries are **A** (inputs 1-4), and **B** (inputs 5-8).

ZCAL Provides the Zero Calibration Constant for each Input

Input: ZCAL <input>, <type>, <value>

Returned: Nothing

Remarks: Provides the zero calibration constant for the selected input. The calibration constant is calculated using the raw A/D data.

<input> Specifies which input to provide zero calibration constant for. Valid entries are 1 - 8.

<type> Specifies the input groups sensor type. Valid entries are:

0 - Silicon Diode	3 - Platinum 100 (500 Ω)
1 - GaAlAs Diode	4 - Platinum 1000
2 - Platinum 100 (250 Ω)	5 - NTC Resistor

<value> Zero Calibration Constant

ZCAL? Returns Value of Zero Calibration Constant for the Selected Input

Input: ZCAL? <input>, <value>

Returned: Returns value of zero calibration constant for the selected input and input configuration.

Remarks: <input> Specifies which input to query zero calibration constant for. Valid entries are 1 - 8.

<type> Specifies the input groups sensor type. Valid entries are:

0 - Silicon Diode	3 - Platinum 100 (500 Ω)
1 - GaAlAs Diode	4 - Platinum 1000
2 - Platinum 100 (250 Ω)	5 - NTC Resistor

GCAL Provides the Gain Calibration Constant for each Input

Input: GCAL <input>, <type>, <value>

Returned: Nothing

Remarks: Provides the gain calibration constant for the selected input. The calibration constant is calculated using the raw A/D data and is multiplied by the necessary constant to supply the corrected value for the input type.

<input> Specifies which input to provide zero calibration constant for. Valid entries are 1 - 8.

<type> Specifies the input groups sensor type. Valid entries are:

0 - Silicon Diode	3 - Platinum 100 (500 Ω)
1 - GaAlAs Diode	4 - Platinum 1000
2 - Platinum 100 (250 Ω)	5 - NTC Resistor

<value> Gain Calibration Constant

GCAL? Returns the Gain Calibration Constant for the Selected Input

Input: GCAL? <input>, <type>

Returned: Value of gain calibration constant for the selected input.

Remarks: See GCAL command for description of returned data.

<input> Specifies which input to query gain calibration constant for. Valid entries are 1 - 8.

<type> Specifies the input groups sensor type. Valid entries are:

0 - Silicon Diode	3 - Platinum 100 (500 Ω)
1 - GaAlAs Diode	4 - Platinum 1000
2 - Platinum 100 (250 Ω)	5 - NTC Resistor

RAWAD? Querys Raw A/D Value for the Selected Input

Input: RAWAD? <input>

Returned: Raw A/D value
Format: n.nnnnnn[term]

Remarks: Returns 7 digit value of selected input reading. Used for ZCAL and GCAL functions.

<input> Specifies which input to query. Valid entries are 1 - 8.

CALCLEAR Returns All Calibration Constants to Their Default Value

Input: CALCLEAR

Returned: Nothing

Remarks: Returns all A/D Linearity, ZCAL, and GCAL calibration constants to their default value.

CALSAVE Saves all Calibration Constants

Input: CALSAVE

Returned: Nothing

Remarks: Saves all A/D Linearity, ZCAL, and GCAL calibration constants.

CHAPTER 8

ACCESSORIES

Model	*Description Of Model CYD218 Accessories*
CYD218S	**Standard Temperature Monitor.** Includes 8 inputs, IEEE-488 and serial interface, alarms, relays, analog output, data logging, and printer support.
CYD218E	**Standard Temperature Monitor.** Includes 8 inputs, serial interface, alarms, data logging, and printer support.
119-007*	**Model CYD218 Temperature Monitor User's Manual.**
106-253*	**Sensor Mating Connector.** Two (2) DB-25 D-Style plugs for sensor input connector.
106-255*	**Sensor Mating Connector Shell.** Two (2) DB-25 D-Style shells for sensor input connector.
106-772*	**Terminal Block Mating Connector.** Two (2) 14-Pin connectors for relays and analog outputs (for 218S ONLY).
115-006*	**Detachable 120 VAC line cord.**
RM-1/2	**Rack Mount Kit.** Mounts one ½ rack temperature monitors in 482.60 mm (19") rack.
RM-2	**Rack Mount Kit.** Mounts two ½ rack temperature monitors in 482.60 mm (19") rack.
4005	**Model CYD218 IEEE-488 Cable Kit.** One meter (3.3' long) IEEE-488 (GPIB) computer interface cable assembly. Includes extender which is required to use both IEEE cable and relay terminal block simultaneously.

*Accessories included with a new Model CYD218.

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APPENDIX A

CURVE TABLES

Table A-1 Standard CYD-SD7 Diode Curve

Breakpoint	V	Temp. (K)	Breakpoint	V	Temp. (K)	Breakpoint	V	Temp. (K)
1	0.09062	475.0	30	0.82405	170.0	59	1.10476	31.0
2	0.10191	470.0	31	0.84651	160.0	60	1.10702	30.0
3	0.11356	465.0	32	0.86874	150.0	61	1.10945	29.0
4	0.12547	460.0	33	0.87976	145.0	62	1.11212	28.0
5	0.13759	455.0	34	0.89072	140.0	63	1.11517	27.0
6	0.14985	450.0	35	0.90161	135.0	64	1.11896	26.0
7	0.16221	445.0	36	0.91243	130.0	65	1.12463	25.0
8	0.17464	440.0	37	0.92317	125.0	66	1.13598	24.0
9	0.18710	435.0	38	0.93383	120.0	67	1.15558	23.0
10	0.19961	430.0	39	0.94440	115.0	68	1.17705	22.0
11	0.22463	420.0	40	0.95487	110.0	69	1.19645	21.0
12	0.24964	410.0	41	0.96524	105.0	70	1.22321	19.5
13	0.27456	400.0	42	0.97550	100.0	71	1.26685	17.0
14	0.28701	395.0	43	0.98564	95.0	72	1.30404	15.0
15	0.32417	380.0	44	0.99565	90.0	73	1.33438	13.5
16	0.36111	365.0	45	1.00552	85.0	74	1.35642	12.5
17	0.41005	345.0	46	1.01525	80.0	75	1.38012	11.5
18	0.44647	330.0	47	1.02482	75.0	76	1.40605	10.5
19	0.45860	325.0	48	1.03425	70.0	77	1.43474	9.5
20	0.50691	305.0	49	1.04353	65.0	78	1.46684	8.5
21	0.51892	300.0	50	1.05630	58.0	79	1.50258	7.5
22	0.55494	285.0	51	1.06702	52.0	80	1.59075	5.2
23	0.60275	265.0	52	1.07750	46.0	81	1.62622	4.2
24	0.63842	250.0	53	1.08781	40.0	82	1.65156	3.4
25	0.67389	235.0	54	1.08953	39.0	83	1.67398	2.6
26	0.70909	220.0	55	1.09489	36.0	84	1.68585	2.1
27	0.74400	205.0	56	1.09864	34.0	85	1.69367	1.7
28	0.77857	190.0	57	1.10060	33.0	86	1.69818	1.4
29	0.80139	180.0	58	1.10263	32.0			

Table A-2. Platinum Curves

Breakpoint Number	PLATINUM 100 OHM		PLATINUM 1000 OHM	
	Ohms	Temp. (K)	Ohms	Temp. (K)
1	3.82000	30.0	38.2000	30.0
2	4.23500	32.0	42.3500	32.0
3	5.14600	36.0	51.4600	36.0
4	5.65000	38.0	56.5000	38.0
5	6.17000	40.0	61.7000	40.0
6	6.72600	42.0	67.2600	42.0
7	7.90900	46.0	79.0900	46.0
8	9.92400	52.0	99.2400	52.0
9	12.1800	58.0	121.800	58.0
10	15.0150	65.0	150.150	65.0
11	19.2230	75.0	192.230	75.0
12	23.5250	85.0	235.250	85.0
13	32.0810	105.0	320.810	105.0
14	46.6480	140.0	466.480	140.0
15	62.9800	180.0	629.800	180.0
16	75.0440	210.0	750.440	210.0
17	98.7840	270.0	987.840	270.0
18	116.270	315.0	1162.70	315.0
19	131.616	355.0	1316.16	355.0
20	148.652	400.0	1486.52	400.0
21	165.466	445.0	1654.66	445.0
22	182.035	490.0	1820.35	490.0
23	198.386	535.0	1983.86	535.0
24	216.256	585.0	2162.56	585.0
25	232.106	630.0	2321.06	630.0
26	247.712	675.0	2477.12	675.0
27	261.391	715.0	2613.91	715.0
28	276.566	760.0	2765.66	760.0
29	289.830	800.0	2898.30	800.0

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